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INITIAL OPERATIONAL TEST AND EVALUATION (IOT&E) OF ASVAB FORMS 11, 12, AND 13: PARALLELISM OF THE NEW FORMS

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Six new forms of the Armed Services Vocational Aptitude Battery (ASVAB) were developed and implemented on 1 October 1984. Between 1 October and 30 November 1984, these new forms and a reference form were administered to approximately 120,000 applicants to the US Armed Forces. Test data were analyzed to assess the parallelism of the new forms in the total sample of applicants who were tested during October and November 1984 and in separate male and female applicant samples. The distributions of subtest scores, the item statistics, and the interrelationships of the subtest scores were compared across the forms. There was some evidence of lower subtest mean scores on Form 12a, although this difference was not consistent for all subtests. Although results differ between the male and female samples, these differences did not appear to be systematically related to the form being administered and thus were not indicative of a sex-by-test-form interaction.

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SUMMARY

In a 1984 revision of the Armed Services Vocational Aptitude Battery (ASVAB), six new forms were developed. During October and November 1984, these new forms and a reference form were administered to 120,000 examinees. These data were then analyzed to assess the parallelism of the new forms in the total sample and in separate male and female samples.

The distributions of subtest scores, the item statistics, and the interrelationships of the scores were compared across the forms. There was some evidence of lower mean scores on Form 12a, although this difference was not consistent for all subtests. Although results differed between the male and female samples, these differences did not appear to be systematically related to the form being administered and thus were not indicative of a sex-by-form interaction. In general, the results supported the parallelism of the new forms.

PREFACE

This technical report and the analyses it describes were completed as part of the Initial Operational Test and Evaluation (IOT&E) of Forms 11a, 11b, 12a, 12b, 13a, and 13b of the Armed Services Vocational Aptitude Battery (ASVAB) Project (Contract F33615-84-C-0062, Work Unit No. 77191842). This document is Volume I of a two volume report. Volume I contains a description of the findings of the study while Volume II contains detailed graphic representation of test information functions, test characteristic curves, and descriptive statistics for the new forms. This project was completed by the MAXIMA Corporation, Rockville, Maryland, and the Assessment Systems Corporation, St. Paul, Minnesota, for the Air Force Human Resources Laboratory, Force Acquisition Branch, San Antonio, Texas.

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INITIAL OPERATIONAL TEST AND EVALUATION (IOT&E) OF ASVAB FORMS 11, 12, AND 13: PARALLELISM OF THE NEW FORMS

I. INTRODUCTION

The Armed Services Vocational Aptitude Battery (ASVAB) is a multiple-aptitude test battery for selection and classification of applicants for the Armed Forces. The ASVAB is periodically revised to maintain test security and to ensure the timeliness of the battery's content. The revision process requires the development of new parallel forms that can be equated to a reference test. Equating enables the armed services to compare the distributions of ability of current applicants to previous applicants and to provide a consistent meaning for the cutting scores used in selection and classification of enlisted personnel (Ree, Mathews, Mullins, & Massey, 1982).

In a recent revision of the ASVAB, six new versions were developed and pretested (Prestwood, Vale, Massey, & Welsh, 1985). The new forms were designated 11a, 11b, 12a, 12b, 13a, and 13b. The reference instrument and all of the new forms consisted of 10 individual subtests: General Science (GS), Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Comprehension (PC), Numerical Operations (NO), Coding Speed (CS), Auto and Shop Information (AS), Mathematics Knowledge (MK), Mechanical Comprehension (MC), and Electronics Information (EI). Scores from four of these subtests--AR, WK, PC, and half-weighted NO--are combined to form the Armed Forces Qualification Test (AFQT). The AFQT is used by all of the armed services for reporting the aptitudes of recruits to Congress. Each of the six test versions has a unique AFQT; that is, items in those subtests which make up the AFQT differ for each version. The remaining six subtests have three sets of unique items: one set for 11a and 11b, one for 12a and 12b, and one for 13a and 13b. The order of the items was altered for the a and b versions of a given form number. To investigate the parallelism of the new forms, to equate them to ASVAB Form 8a, and to develop equating tables for interim operational use, the new forms were administered to 92,973 recruits in the Recruit Training Centers (RTCs) and Military Entrance Processing Stations (MEPS; Prestwood et al., 1985).

The next step in the development of new ASVAB forms is the IOT&E of the tests and their equating under operational test conditions. Approximately 119,000 individuals were tested at the MEPS using one of the new forms of the ASVAB or a reference form (ASVAB 8a) between October and November of 1984. This report describes the procedures and results of the analyses used to evaluate the parallelism of the new forms when used under operational testing conditions. A companion report (Ree, Welsh, Wegner, & Earles, 1985) describes the evaluation of the equating of the new forms.

There were three major steps in the analyses of the parallelism of the new ASVAB forms. First, the data were edited to verify the accuracy of the identifying form number and to identify for possible deletion those examinees with too few responses, inappropriate responses, or deviant subtest scores. Second, the parallelism of the forms was evaluated by identifying sampling variations across forms, by identifying differences in the distributions or structure of the scores across forms and across sexes within forms, and by identifying differences in item statistics on the power subtests across forms and across sexes within forms. Third, composite scores were calculated, and variations in distribution across forms and across sexes within forms were evaluated.

II. DATA EDITING

The examinee data were evaluated using sequential editing procedures. Failure to meet a criterion at any stage of the editing process resulted in the elimination of the examinee from all further analyses.

Procedure

The first editing procedure eliminated any examinee whose form number was not coded as 11a, 11b, 12a, 12b, 12a, or 13c. (The reference test, ASVAB 8a, was reprinted, designated as "ASVAB 13c," and coded as such on the answer sheet.) The second procedure examined the data for a low level of response. All examinees with fewer than five responses on any subtest were deleted from the sample.

Using the cases remaining after the first two editing procedures, the third procedure assessed the accuracy of the recorded form numbers. If an individual's proportion of correct responses over all items attempted was greater than 0.3 when scored with the key corresponding to the recorded form number, the form number was assumed to be correct, and the subject was retained in the sample. If the proportion correct was less than or equal to 0.3, the examinee's responses were rescored using each of the other keys. If an alternative key yielded a proportion correct greater than or equal to 0.5, the form number was considered questionable, and the examinee was deleted from the sample. This editing procedure was used in the development of the new forms (Prestwood et al., 1985) and is an operationalization of the key-verification procedure described briefly by Ree, Mathews, Mullins, and Massey (1982, p. 10).

The final data editing procedure identified examinees with deviant subtest scores. Multiple regression was used to predict an examinee's performance on each subtest from performance on the other nine subtests. If an examinee's actual scores on two or more subtests fell more than three standard errors of estimate below the scores predicted for those subtests, the examinee's data were deleted from the sample. This editing procedure was similar to the one used in the development of Forms 11, 12, and 13, except that in this study, separate regression equations were developed for each form of the ASVAB, while the previous study used only one regression equation based on the 8a data (Prestwood et al., 1985). This check for deviant subtest scores is an extension of the editing procedure described by Ree, Mathews, Mullins, and Massey (1982, pp. 10-11).

Results

Results from the editing procedures are summarized in Table 1. Data from 119,533 individuals were edited. A total of 677 examinees were eliminated from the sample because their form number was not coded properly. Thus, 0.57% of the sample was removed from further analysis at this stage of editing. An additional 400 examinees were deleted from the sample for responding to fewer than five items on at least one subtest. These examinees constituted 0.33% of the total sample. Then 144 examinees (0.12%) were deleted from the sample because the form number recorded by the examinee was considered questionable. The last editing procedure eliminated 32 examinees (0.03%) for deviant subtest scores. After the editing process was completed, 99% of the original sample (118,280 examinees) had been retained for further analysis.

Table 1. Summary of Results of Data Editing

Category	Number	Percent of total
Total Cases Scanned	119,533	100.00
Bad Cases	1,253	1.05
Incorrect Form Coding	677	.57
Too Few Responses	400	.33
Form Number Error	144	.12
Deviant Subtest Scores	32	.03
Good Cases	118,280	98.95

Table 2 summarizes the results of the editing procedures by form number. This table does not include the 677 examinees eliminated by the first procedure. The number of examinees varied across forms: the greatest number of examinees took Form 11a, and approximately 4,000 fewer completed Form 13b. The proportion of examinees eliminated because of too few responses was fairly consistent across forms, ranging from 0.0038 (Form 13b) to 0.0029 (Form 11b). There was a low rate of elimination for deviant subtests across all forms.

Table 2. Results of Data Editing by Form

	Form number						
Category	11a	11b	12a	12b	13a	13b	13c(8a)
Total Cases Scanned	19011	17884	18460	17443	15989	14921	15148
Bad Cases	67	59	83	97	69	118	83
Too Few Responses	58	52	68	62	55	56	49
Form Number Error	2	4	9	29	10	61	29
Deviant Subtests	7	3	6	6	4	1	5
Good Cases	18944	17825	18377	17346	15920	14803	15065
Percent Good Cases	99.65	99.67	99.55	99.44	99.57	99.21	99.45

There was some variability in form number accuracy across forms. Typically, the better fitting alternate key did not show a systematic pattern, except for the examinees deleted from Forms 13a and 13b. Sixty percent of the cases deleted from Form 13a and 74% of the cases deleted from Form 13b were eliminated because the key for Form 13c fit better. A probable explanation for the frequency with which the key fit the responses on tests coded 13a and 13b was that there was no labeled box on the answer sheet for indicating Form 13c. Examinees were instructed to fill in an unmarked box directly below the box for version 13b. Many examinees taking Form 13c blackened the box for another form labeled with a 13.

Conclusions

More than 99% of the examinees taking each form were retained for analysis. There were no systematic patterns of examinee elimination (by form) except for the form number problems associated with Forms 13a, 13b, and 13c.

III. DEMOGRAPHIC STATISTICS

An assumption underlying the analysis of the IOT&E data is that the groups completing each form were equivalent. Demographic statistics were compiled by form number to evaluate the equivalence of the groups. Of interest was the identification of sampling variation between the forms, particularly in the distributions of sex, race, and education level.

Procedure

Data were collected for several demographic variables. To identify sampling variation, this information (sex, population group, education level, and testing site) was summarized by frequencies of the characteristics for the sample administered each form. The frequencies were then converted to percentages within a form to facilitate comparisons across forms.

Results

Table 3 shows the frequencies by form within each demographic category. The examinees were primarily White males with at least 12 years of schooling. Table 4 summarizes some of the demographic information by percentages within a form. Eighty-four percent (83% for Form 13c) of the examinees taking each form were male.

Approximately 67% of the examinees were White, and approximately 23% were Black. This was consistent across all forms, with less than 1% difference in the frequency of Whites across forms and less than 2% difference in the frequency of Blacks.

Education level was also consistent across forms. Approximately 69% of the examinees had at least 12 years of education. The distributions of years of education were consistent across forms; differences between forms were less than 1%.

Conclusions

Since the distributions of sex, race, and education level were consistent across forms in the sample, the groups of examinees were considered equivalent. There were no indications of sampling variations in sex, race, or education level that would bias further analyses.

IV. SUBTEST SUMMARY STATISTICS

Descriptive statistics were calculated for each subtest within each form to help identify differences in the distribution of subtest scores among forms. Subtest statistics were also calculated using only male and only female examinees in order to evaluate the differences between sexes and any sex-by-form interactions. These statistics were computed on the edited samples.

Table 3. Demographic Summary for Edited Cases

	Form number						
Characteristic	11a	11b	12a	12b	13a	13b	13c(8a)
N Examinees	18944	17825	18377	17346	15920	14803	15065
Sex							
Male	15919	15036	15520	14626	13425	12484	12502
Female	3025	2788	2856	2719	2493	2318	2561
Omit/Miscoded	0	1	1	1	2	1	2
Population Group							
American Indian	179	172	171	180	171	156	159
Hispanic	1138	991	1085	987	934	887	688
Asian	203	198	239	200	191	184	203
Black	4342	4266	4126	4032	3647	3328	3625
White	12727	11872	12401	11615	10677	9949	10128
Other	335	301	337	314	297	287	248
Omit/Miscoded	20	25	18	18	13	12	14
Education Level							
8 or less	60	57	65	50	54	45	50
9	313	274	296	244	250	248	243
10	893	833	823	754	798	735	680
11	4401	4159	4287	4073	3661	3517	3577
12	1544	1505	1533	1452	1278	1155	1139
GED	1165	1097	1095	1113	953	919	921
HS	7485	6936	7246	6823	6321	5817	5989
13+	2958	2837	2880	2718	2504	2232	2349
Omit/Miscoded	125	127	152	119	101	135	117
Service							
Air Force	3311	3133	3147	3045	2777	2634	2643
Active	2580	2451	2497	2401	2177	2010	2099
Reserve	299	279	274	280	255	216	250
Natl Guard	431	399	373	360	342	306	291
Omit/Miscode	1	4	3	4	3	2	3
Army	10063	9514	9699	9174	8354	7880	7814
Active	6645	6310	6429	6137	5460	5114	5110
Reserve	1692	1612	1683	1561	1461	1400	1391
Natl Guard	1707	1580	1570	1453	1415	1355	1298
Omit/Miscode	19	12	17	23	18	11	15
Marine Corps	1838	1699	1803	1645	1553	1417	1519
Active	1529	1399	1468	1333	1277	1164	1242
Reserve	304	300	335	310	274	252	275
Natl Guard	0	0	0	0	0	0	0
Omit/Miscode	5	0	0	2	2	1	2
Navy	3515	3299	3517	3310	3086	2816	2914
Active	3106	2870	3093	2906	2729	2501	2544
Reserve	402	428	418	400	354	311	367
Natl Guard	0	0	0	0	1	0	0
Omit/Miscode	7	1	6	4	2	4	3

Table 3. (Concluded)

Characteristic	Form number						
	11a	11b	12a	12b	13a	13b	13c(8a)
Coast Guard	211	178	205	169	144	153	171
Active	159	138	164	138	113	122	131
Reserve	52	40	41	31	31	30	40
Natl Guard	0	0	0	0	0	0	0
Omit/Miscode	0	0	0	0	0	1	0
Miscoded Service	6	2	6	3	6	3	4

Table 4. Percent of Edited Cases in Selected Demographic Categories

Characteristic	Form number						
	11a	11b	12a	12b	13a	13b	13c(8a)
Sex							
Male	84.0	84.4	84.5	84.3	84.3	84.3	83.0
Female	16.0	15.6	15.5	15.6	15.7	15.7	17.0
Population Group							
White	67.2	66.6	67.5	67.0	67.0	67.2	67.2
Black	22.9	23.9	22.5	23.2	22.9	22.5	24.1
Hispanic	6.0	5.6	5.9	5.7	5.9	6.0	4.6
Other	3.9	3.9	4.1	4.1	4.2	4.3	4.1
Education Level							
10 or less	6.7	6.5	6.4	6.0	6.9	6.9	6.5
11	23.2	23.3	23.3	23.5	23.0	23.8	23.7
12 (GED, Diploma)	53.8	53.5	53.7	54.2	53.7	53.3	53.5
13 or more	15.6	15.9	15.7	15.7	15.7	15.1	15.6
Other	.7	.7	.8	.7	.6	.9	.8

Descriptive Statistics

Procedure

Three sets of analyses were performed: one for the total sample, one for males, and one for females. The mean, variance, standard deviation, skew, kurtosis, minimum score, maximum score, range, median, and mode were calculated for each subtest on each form. Because of the large sample sizes and the large number of tests that would be required, tests of statistical significance would not be very informative and were therefore not used to evaluate the differences observed. The means and variances for each subtest in each form are shown in Tables 5 through 7. Complete summaries of these analyses are shown in Appendices C and D in Volume II.

Results

Total Sample. Table 5 shows the subtest means and variances calculated for the total sample. In three of the 10 subtests (WK, NO, and MK), the reference form had a higher mean value than any new form. It was not surprising, then, that the highest mean value for the AFQT composite was found for Form 13c. Among the new forms, 13a had the highest mean on four of the 10 subtests (AR, AS, MK, and MC). In contrast, for four of the 10 subtests (PC, NO, AS, and MK), Form 12a had the lowest mean value. This pattern was reflected in the AFQT composite where Form 12a had a mean that was more than two points lower than the average for the other new forms. Form 13c had the smallest variances for seven of the 10 subtests, and the lowest variance for the AFQT composite.

Males and Females. Table 6 shows the subtest means and variances for males, and Table 7 shows the subtest means and variances for females. For males, the ranges of mean scores across the forms were typically less than one point. However, for the NO, PC, and CS subtests, the differences were larger--up to 3.5 points on NO. The compensatory nature of adding scores to obtain AFQT scores accounts for the less than one-point difference for the composites.

Differences across forms in female mean scores were greatest for the AR and NO subtests. Both of these subtests showed a range of mean scores of more than one point across the new forms. NO had the largest range (4.5) across the forms.

The descriptive statistics of the subtests show no evidence of systematic sex-by-form interaction. The largest difference between sexes occurred on PC, NO, and CS on Form 11b, favoring females. Form 11b also showed the largest difference between sexes on AR, but this difference favored males. On the other six subtests, Form 11b showed either the least or a very small difference between sexes.

Form 12b showed a similar pattern. For MK, MC, and EI, Form 12b showed the largest difference between sexes, favoring males. However, on NO and CS, 12b had the second highest difference between sexes, favoring females.

Males, on the average, scored 4.987 points higher overall than females on Form 12b, and 2.5 points higher overall on Form 11b. The other forms fell between these two extremes, with males favored by 3.403 points overall on Form 11a, 4.231 on Form 12a, 4.681 on Form 13b, and 4.834 on Form 13a. There was, at most, a 2.500-point difference between the forms exhibiting the largest and smallest differences between sexes.

Conclusions

The new forms were evaluated first for the total sample, then for the male and female samples. In each of the three sets of analyses--total, male, and female--there was evidence that scores on Form 12a tended to be lower than scores on the other forms. In the total sample, the lowest means occurred on four of the 10 subtests on Form 12a. However, on only one subtest (NO) was this difference greater than one point. The lower means associated with Form 12a are, however, reflected in a lower mean score on the AFQT composite.

In the male sample, the ranges of subtest mean scores across the new forms were less than one point for seven of the ten subtests. The lowest mean scores were on Form 12a and the highest on Form 13a. Scores on Form 13a, however, were similar to those of the other four forms. Form 12a tended to have much lower mean scores, particularly on PC and NO.

Table 5. Total Sample Means and Variances for Subtests and AFQT Composite

Statistic	Form number						
	11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
Mean	16.177	16.138	16.695	16.743	16.498	16.356	15.933
Variance	25.698	25.417	22.522	21.940	26.383	27.330	19.627
Arithmetic Reasoning							
Mean	18.820	18.672	19.020	19.016	19.291	19.152	17.813
Variance	46.592	45.251	42.588	46.857	39.225	40.333	41.641
Word Knowledge							
Mean	25.360	25.258	25.318	25.427	25.176	25.762	26.620
Variance	50.690	44.617	49.286	48.068	47.285	46.767	36.429
Paragraph Comprehension							
Mean	11.236	10.858	10.370	11.644	11.283	11.018	11.288
Variance	9.308	9.754	9.860	8.584	9.729	9.823	7.481
Numerical Operations							
Mean	37.355	38.330	34.689	35.733	37.172	36.274	38.579
Variance	70.911	76.708	80.524	80.945	78.014	77.014	76.482
Coding Speed							
Mean	49.689	49.804	50.047	50.380	49.901	50.667	49.104
Variance	171.189	164.720	175.117	172.193	169.678	168.795	163.534
Auto and Shop Information							
Mean	15.667	15.565	15.098	15.255	15.756	15.716	15.448
Variance	31.318	31.302	31.473	30.880	28.894	29.123	26.921
Mathematics Knowledge							
Mean	12.925	12.830	12.587	12.600	13.043	12.993	13.172
Variance	34.452	35.049	39.159	39.387	33.215	33.750	31.017
Mechanical Comprehension							
Mean	15.172	15.272	15.309	15.350	15.416	15.272	15.080
Variance	23.443	23.424	23.934	23.835	22.667	22.661	25.826
Electronics Information							
Mean	11.598	11.841	12.473	12.593	12.171	12.010	11.895
Variance	16.139	16.076	16.410	15.853	15.930	16.537	15.045
AFQT Composite							
Mean	74.094	73.953	72.053	73.954	74.336	74.070	75.010
Variance	306.028	284.300	297.345	299.681	283.777	289.097	247.097

Table 6. Male Sample Means and Variances for Subtests and AFQT Composite

Statistic	Form number 11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
Mean	16.373	16.320	16.949	16.998	16.786	16.638	16.210
Variance	26.315	25.822	22.751	22.249	26.403	27.426	19.950
Arithmetic Reasoning							
Mean	19.016	18.896	19.150	19.209	19.410	19.333	18.063
Variance	47.315	45.708	43.290	47.016	40.248	40.877	42.450
Word Knowledge							
Mean	25.256	25.242	25.228	25.337	25.205	25.732	26.651
Variance	51.761	44.928	49.989	48.924	48.212	47.383	36.441
Paragraph Comprehension							
Mean	11.170	10.754	10.302	11.651	11.218	10.991	11.204
Variance	9.664	9.980	10.098	8.823	9.926	10.004	7.703
Numerical Operations							
Mean	36.864	37.723	34.247	35.237	36.683	35.784	38.010
Variance	71.303	77.231	80.450	81.314	78.311	76.224	76.886
Coding Speed							
Mean	48.469	48.591	48.876	49.171	48.759	49.498	47.904
Variance	163.694	153.985	167.924	162.353	161.815	159.815	155.851
Auto and Shop Information							
Mean	16.620	16.510	16.054	16.210	16.721	16.666	16.313
Variance	28.224	28.255	28.171	27.508	26.162	26.460	25.060
Mathematics Knowledge							
Mean	13.027	12.877	12.655	12.721	13.105	13.066	13.162
Variance	35.287	35.976	40.117	40.408	33.972	34.479	31.739
Mechanical Comprehension							
Mean	15.698	15.769	15.832	15.891	15.955	15.788	15.730
Variance	22.726	22.581	23.283	23.146	22.072	22.144	24.993
Electronics Information							
Mean	12.040	12.278	12.968	13.097	12.622	12.460	12.397
Variance	16.060	15.891	15.805	15.207	15.409	15.984	14.394
AFQT Composite							
Mean	73.875	73.754	71.804	73.815	74.174	73.948	74.923
Variance	315.609	291.478	304.332	307.003	292.863	294.692	254.252

Table 7. Female Sample Means and Variances for Subtests and AFQT Composite

Statistic	Form number 11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
Mean	15.143	15.157	15.312	15.366	14.944	14.836	14.580
Variance	21.185	22.039	19.018	18.044	23.435	24.093	15.862
Arithmetic Reasoning							
Mean	17.789	17.467	18.312	17.980	18.654	18.185	16.595
Variance	41.538	41.052	38.195	44.746	33.268	36.288	35.889
Word Knowledge							
Mean	25.903	25.352	25.807	25.908	25.017	25.925	26.469
Variance	44.719	42.866	45.208	43.223	42.305	43.456	36.371
Paragraph Comprehension							
Mean	11.584	11.416	10.740	11.611	11.634	11.163	11.698
Variance	7.294	8.151	8.408	7.304	8.533	8.829	6.191
Numerical Operations							
Mean	39.942	41.608	37.087	38.402	39.807	38.921	41.367
Variance	60.908	61.045	74.156	70.554	68.256	72.990	65.123
Coding Speed							
Mean	56.106	56.359	56.409	56.882	56.054	56.967	54.976
Variance	161.677	171.317	166.395	175.102	167.318	170.206	159.468
Auto and Shop Information							
Mean	10.656	10.472	9.897	10.119	10.556	10.598	11.223
Variance	17.719	16.978	17.410	17.726	11.568	12.413	14.509
Mathematics Knowledge							
Mean	12.388	12.580	12.216	11.947	12.710	12.599	13.224
Variance	29.725	29.979	33.807	33.394	29.022	29.665	27.492
Mechanical Comprehension							
Mean	12.403	12.593	12.470	12.438	12.513	12.494	11.902
Variance	18.090	19.450	17.930	17.492	15.898	16.300	17.734
Electronics Information							
Mean	9.270	9.488	9.780	9.882	9.741	9.587	9.444
Variance	10.107	10.515	11.122	10.613	11.743	12.556	10.992
AFQT Composite							
Mean	75.247	75.039	73.402	74.700	75.209	74.734	75.446
Variance	254.117	243.650	257.331	259.840	234.236	258.564	211.901

In the female sample, the ranges of subtest mean scores across the new forms were less than one point for eight of the ten subtests. The lowest mean scores occurred on Form 12a, with the scores on the NO subtest being particularly low. There was, however, no evidence of a systematic sex-by-form interaction. For instance, both males and females tended to score lower on Form 12a.

Subtest Reliability and Standard Error of Measurement (SEM)

Analysis of the subtest reliabilities and SEM across forms in the total, male, and female samples provided further evidence for the evaluation of the parallelism of the forms.

Procedure

Three sets of analyses were run: one for the total sample, one for males, and one for females. Internal-consistency measures of reliability were calculated for each power subtest. The Kuder-Richardson formula 20 (KR-20) was used to estimate reliability. Because KR-20 is not suitable for speeded tests, no estimates of reliability were calculated for the NO and CS subtests. The SEM was also calculated for each power subtest for the total, male, and female samples.

Results

Total Sample. Table 8 shows the reliabilities and SEMs for each subtest, computed on the total sample. As expected, reliability was related to test length. The greatest average reliability across the new forms was found on WK, the power subtest with the most items. WK had an average internal consistency of 0.900. The lowest average reliabilities were found on the shorter subtests. The average internal consistency over the new forms for the PC subtest was 0.777, and the average for the EI subtest was 0.770.

The greatest differences between forms in the estimate of internal consistency (KR-20) occurred on the subtests of GS (0.025), MK (0.025), and PC (0.026). The subtest with the most consistent reliabilities across the new forms was MC, where the difference between the highest and lowest values for KR-20 was only 0.009.

The greatest difference between any subtest's average reliability across the new forms and the reliability of its reference subtest was 0.075 on the PC subtest. In six of the eight subtests (reliabilities were not calculated for the speeded subtests), the difference between the reference subtest reliability and the average subtest reliability for the new forms was less than 0.030, with the lowest difference (0.007) occurring in AR.

The PC subtest had the lowest average SEM for the new forms (1.455) and AR had the highest (2.229). Within each subtest, the range of SEMs across the new forms was quite low; these ranges varied between 0.019 and 0.125. The widest range of SEMs occurred on the PC subtest.

Males. Table 9 shows the reliabilities and SEMs for each subtest, computed on the male sample. The subtest reliabilities calculated for the male sample were similar to those for the total sample. WK showed the highest average reliability (0.901) over the new forms, and PC and EI showed the lowest (0.782 and 0.770, respectively). The greatest difference between reliability estimates on a subtest was 0.025 for PC. The most consistent reliabilities across the new forms were found for MC. The average subtest reliability for the new forms was higher than that on the reference form for all subtests except MC.

Table 8. Total Sample Subtest Reliabilities and SEM

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
KR-20	0.843	0.841	0.832	0.827	0.847	0.852	0.786
SEM	2.008	2.009	1.946	1.947	2.008	2.012	2.050
Arithmetic Reasoning							
KR-20	0.895	0.889	0.886	0.893	0.874	0.873	0.878
SEM	2.214	2.242	2.199	2.235	2.224	2.259	2.252
Word Knowledge							
KR-20	0.905	0.892	0.904	0.901	0.897	0.900	0.876
SEM	2.196	2.199	2.170	1.183	2.208	2.166	1.126
Paragraph Comprehension							
KR-20	0.783	0.770	0.767	0.775	0.793	0.776	0.702
SEM	1.422	1.497	1.514	1.389	1.420	1.485	1.494
Auto and Shop Information							
KR-20	0.858	0.857	0.861	0.859	0.848	0.849	0.832
SEM	2.107	2.115	2.093	2.087	2.098	2.099	2.125
Mathematics Knowledge							
KR-20	0.869	0.871	0.892	0.892	0.867	0.870	0.855
SEM	2.121	2.125	2.060	2.061	2.103	2.095	2.120
Mechanical Comprehension							
KR-20	0.805	0.806	0.809	0.808	0.802	0.800	0.819
SEM	2.137	2.133	2.139	2.138	2.120	2.129	2.163
Electronics Information							
KR-20	0.768	0.769	0.770	0.764	0.770	0.779	0.759
SEM	1.934	1.926	1.943	1.933	1.915	1.911	1.905

As in the total sample, PC had the lowest average SEM for a new form (1.459) and AR had the highest (2.219). The widest range of SEMs across the new forms was observed for PC (0.132), and the smallest was observed for MC (0.022). For eight of the ten subtests, the average SEM for the new forms was smaller than the SEM for the reference form. There did not appear to be systematic SEM differences attributable to form.

Table 10 shows the reliabilities and SEMs for each subtest, computed on the female sample. The reliabilities in the female sample were lower than for the male and total samples on all subtests. The WK subtest had the highest reliability (0.892), as in the male and total samples. Unlike the male and total sample results, however, one of the lowest reliabilities occurred on AS (0.549). EI again showed the lowest average reliability over all subtests (0.622).

Table 9. Male Sample Subtest Reliabilities and SEM

Statistic	Form number						
	11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
KR-20	0.849	0.846	0.837	0.833	0.851	0.856	0.794
SEM	1.993	1.997	1.929	1.928	1.986	1.990	2.026
Arithmetic Reasoning							
KR-20	0.898	0.891	0.889	0.895	0.878	0.876	0.881
SEM	2.202	2.232	2.191	2.223	2.214	2.249	2.243
Word Knowledge							
KR-20	0.907	0.892	0.906	0.902	0.900	0.901	0.877
SEM	2.198	2.198	2.170	2.184	2.201	2.165	2.116
Paragraph Comprehension							
KR-20	0.788	0.773	0.771	0.782	0.796	0.779	0.707
SEM	1.430	1.506	1.519	1.387	1.423	1.486	1.503
Auto and Shop Information							
KR-20	0.848	0.847	0.850	0.847	0.839	0.840	0.826
SEM	2.072	2.081	2.058	2.050	2.055	2.057	2.088
Mathematics Knowledge							
KR-20	0.874	0.876	0.894	0.895	0.871	0.874	0.859
SEM	2.111	2.115	2.058	2.059	2.096	2.088	2.116
Mechanical Comprehension							
KR-20	0.804	0.802	0.808	0.807	0.801	0.800	0.818
SEM	2.113	2.112	2.117	2.115	2.095	2.105	2.135
Electronics Information							
KR-20	0.773	0.773	0.768	0.762	0.768	0.777	0.755
SEM	1.909	1.898	1.914	1.903	1.889	1.888	1.879

The ranges of reliabilities across forms for a given subtest were generally higher than the ranges seen for the male sample. The smaller ranges of reliabilities (0.015 to 0.038) across the new forms occurred on the subtests requiring general knowledge (AR, WK, PC, and MK). The wider ranges of reliabilities across the new forms (0.043 to 0.167) occurred on the subtests requiring more specialized knowledge (GS, AS, MC, and EI). The widest range (0.167) occurred on AS, where the reliabilities associated with Forms 13a and 13b were lower. The lower reliabilities were associated with the smaller variances on these two forms. The average new subtest reliabilities were higher than their corresponding reference subtest reliabilities, except for EI.

The SEM results for the female sample were similar to those for the total and male samples. The new PC subtests had the lowest average SEM (1.427), yet they had the widest range of SEMs (0.113). AR had the highest average SEM (2.272).

Table 10. Female Sample Subtest Reliabilities and SEM

Statistic	Form number						
	11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
KR-20	0.803	0.811	0.790	0.776	0.815	0.819	0.721
SEM	2.044	2.043	1.998	2.011	2.085	2.090	2.105
Arithmetic Reasoning							
KR-20	0.877	0.873	0.870	0.883	.845	0.854	0.855
SEM	2.264	2.281	2.231	2.283	2.267	2.304	2.279
Word Knowledge							
KR-20	0.895	0.889	0.898	0.893	0.883	0.893	0.873
SEM	2.165	2.186	2.151	2.149	2.229	2.155	2.151
Paragraph Comprehension							
KR-20	0.742	0.734	0.738	0.736	0.770	0.754	0.663
SEM	1.371	1.443	1.484	1.390	1.400	1.474	1.445
Auto and Shop Information							
KR-20	0.716	0.703	0.711	0.715	0.549	0.580	0.653
SEM	2.245	2.246	2.242	2.247	2.284	2.282	2.243
Mathematics Knowledge							
KR-20	0.844	0.844	0.875	0.873	0.843	0.848	0.835
SEM	2.154	2.162	2.058	2.056	2.132	2.126	2.129
Mechanical Comprehension							
KR-20	0.720	0.744	0.720	0.713	0.685	0.692	0.706
SEM	2.250	2.232	2.241	2.239	2.239	2.242	2.282
Electronics Information							
KR-20	0.594	0.607	0.612	0.594	0.648	0.675	0.632
SEM	2.026	2.032	2.078	2.075	2.033	2.020	2.012

Conclusions

The subtest reliabilities for the new forms were quite high (0.7 to 0.9) in the total and male samples, and somewhat lower (0.6 to 0.9) in the female sample. The reliabilities for the new forms were higher, in general, than those associated with the reference form. Reliabilities were consistent across the new forms in the total and male samples. In the female sample, the reliabilities were more variable across the new forms, but were nevertheless very consistent except for AS. There was no evidence of a sex-by-form effect on subtest reliabilities.

Similar consistency across the new forms was found for the SEM. In the total sample, the range of the estimates of SEM across the new forms was generally less than 0.07, except for the PC subtest, which showed a difference in SEM of 0.125 between that estimated for Forms 12a and 12b. Similar patterns were seen in the male and female samples. There was no apparent differential effect of form on the estimates of SEM in the male and female samples.

Subtest Intercorrelations

The intercorrelations of subtests within each form were compared across forms in the total sample to evaluate the comparability of forms in terms of their subtest score interrelationships.

Procedure

The variance-covariance matrix and Pearson product-moment correlations were computed for the ten subtests within each form. The squared correlation is a measure of the strength of the relationship between the scores on two subtests and describes the amount of variance in the scores of one subtest which can be explained by its relationship with the other subtest scores. The difference in the amount of variance explained on a subtest between forms was used to assess the comparability of the interrelationships between subtests as a function of form. Differences across forms of 0.100 (10% of the variance) or greater are reported.

Results

The variances-covariances and Pearson product-moment correlations computed in the total sample are summarized in Tables 11 through 17. The differences between the squared correlations were compared across forms for each subtest pair in the total sample. There were 19 instances (out of 945 possible comparisons) where the difference in the amount of variance accounted for by the relationship between two subtests was greater than 0.100 between two forms. Eleven of these involved differences between subtest pairs on Form 13c and subtest pairs on other forms. The subtest most frequently involved in the larger differences was PC. Differences in the squared correlations of PC and GS occurred between Forms 11a and 13c (0.152), Forms 12b and 13c (0.102), Forms 13a and 13c (0.129), and Forms 13b and 13c (0.145). Differences in the squared correlations of PC and MC occurred on Forms 11a and 13c (0.105), Forms 12b and 13c (0.149), and Forms 13b and 13c (0.123). Differences in the squared correlations of PC and EI occurred between Forms 11b and 13b (0.114) and Forms 12a and 13b (0.121). There was also a large difference (0.103) in the amount of variance accounted for in the relationship between PC and WK on Forms 12a and 13b.

Table 11. Total Sample Variances-Covariances and Intercorrelations for Form 11a

	Subtest									
	GS	AR	WK	PC	NO	CS	AS	MK	MC	EI
GS	25.698	22.552	28.896	10.922	13.264	18.710	14.934	18.411	16.260	13.714
AR	0.652	46.592	31.234	13.547	28.089	35.889	17.616	30.189	22.168	15.586
WK	0.801	0.643	50.690	16.413	19.869	31.495	19.284	22.983	21.225	17.699
PC	0.706	0.650	0.756	9.308	11.364	16.870	6.744	10.190	8.515	6.594
NO	0.311	0.489	0.331	0.442	70.911	71.735	4.088	24.308	11.327	6.561
CS	0.282	0.402	0.338	0.423	0.651	171.189	6.548	30.100	16.637	10.068
AS	0.526	0.461	0.484	0.395	0.087	0.089	31.318	9.658	17.722	15.124
MK	0.619	0.754	0.550	0.569	0.492	0.392	0.294	34.452	16.175	11.543
MC	0.662	0.671	0.616	0.576	0.278	0.263	0.654	0.569	23.443	13.093
EI	0.673	0.568	0.619	0.538	0.194	0.192	0.673	0.490	0.673	16.139

Note. Variances are on the diagonal, covariances are shown above the diagonal, and intercorrelations are shown below the diagonal.

Table 12. Total Sample Variances-Covariances and Intercorrelations for Form 11b

	Subtest									
	GS	AR	WK	PC	NO	CS	AS	MK	MC	EI
GS	25.417	21.867	26.574	10.334	11.710	17.872	14.996	18.334	16.104	13.780
AR	0.645	45.251	29.097	12.633	25.526	34.231	17.465	29.557	21.826	15.359
WK	0.789	0.648	44.617	15.079	15.426	27.114	18.993	21.346	20.518	16.824
PC	0.656	0.601	0.723	9.754	10.932	17.045	6.503	9.771	8.111	6.260
NO	0.265	0.433	0.264	0.400	76.708	70.567	1.846	24.178	9.635	5.245
CS	0.276	0.396	0.316	0.425	0.628	164.720	6.322	30.011	16.076	10.146
AS	0.532	0.464	0.508	0.372	0.038	0.088	31.302	9.657	17.990	15.159
MK	0.614	0.742	0.540	0.528	0.466	0.395	0.292	35.049	16.100	11.485
MC	0.660	0.670	0.635	0.537	0.227	0.259	0.664	0.562	23.424	13.024
EI	0.682	0.569	0.628	0.500	0.149	0.197	0.676	0.484	0.671	16.076

Note. Variances are on the diagonal, covariances are shown above the diagonal, and intercorrelations are shown below the diagonal.

Table 13. Total Sample Variances-Covariances and Intercorrelations for Form 12a

	Subtest									
	GS	AR	WK	PC	NO	CS	AS	MK	MC	EI
GS	22.522	18.764	25.685	9.769	12.533	16.554	15.262	18.176	15.883	12.853
AR	0.606	42.588	27.471	12.373	32.104	35.438	16.140	31.641	20.903	14.055
WK	0.771	0.600	49.286	15.287	20.122	28.989	19.689	23.799	21.090	16.360
PC	0.656	0.604	0.693	9.860	12.990	17.875	6.879	11.074	8.338	6.272
NO	0.294	0.548	0.319	0.461	80.524	73.254	4.600	28.244	12.568	7.303
CS	0.264	0.410	0.312	0.430	0.617	175.117	6.169	32.050	17.010	10.202
AS	0.573	0.441	0.500	0.391	0.091	0.083	31.473	11.719	18.289	15.827
MK	0.612	0.775	0.542	0.564	0.503	0.387	0.334	39.159	18.580	12.651
MC	0.684	0.655	0.614	0.543	0.286	0.263	0.666	0.607	23.934	13.565
EI	0.669	0.532	0.575	0.493	0.201	0.190	0.696	0.499	0.684	16.410

Note. Variances are on the diagonal, covariances are shown above the diagonal, and intercorrelations are shown below the diagonal.

Table 14. Total Sample Variances-Covariances and Intercorrelations for Form 12b

	Subtest									
	GS	AR	WK	PC	NO	CS	AS	MK	MC	EI
GS	21.940	19.541	25.280	9.189	12.217	16.186	14.709	18.153	15.479	12.464
AR	0.609	46.857	28.615	12.525	32.420	36.586	17.454	32.931	21.955	14.661
WK	0.778	0.603	48.068	14.997	20.127	29.197	18.814	24.678	20.754	15.842
PC	0.670	0.625	0.738	8.584	11.115	15.223	7.683	10.246	8.764	6.381
NO	0.290	0.526	0.323	0.422	80.945	74.484	4.057	28.803	12.374	6.955
CS	0.263	0.407	0.321	0.396	0.631	172.193	5.837	32.212	16.824	9.531
AS	0.565	0.459	0.488	0.472	0.081	0.080	30.880	11.857	18.133	15.493
MK	0.618	0.767	0.567	0.557	0.510	0.391	0.340	39.387	18.742	12.523
MC	0.677	0.657	0.613	0.613	0.282	0.263	0.668	0.612	23.835	13.316
EI	0.668	0.538	0.574	0.547	0.194	0.182	0.700	0.501	0.685	15.853

Note. Variances are on the diagonal, covariances are shown above the diagonal, and intercorrelations are shown below the diagonal.

Table 15. Total Sample Variances-Covariances and Intercorrelations for Form 13a

	Subtest									
	GS	AR	WK	PC	NO	CS	AS	MK	MC	EI
GS	26.383	20.087	27.825	11.051	12.140	16.819	14.378	17.720	16.063	14.533
AR	0.624	39.225	27.292	12.412	26.907	33.022	14.363	26.743	19.588	14.575
WK	0.788	0.634	47.285	16.111	18.241	27.598	16.277	21.992	19.536	18.022
PC	0.690	0.635	0.751	9.729	11.258	16.231	6.475	9.951	8.397	7.281
NO	0.268	0.486	0.300	0.409	78.014	72.842	2.056	24.460	10.776	7.408
CS	0.251	0.405	0.308	0.399	0.633	169.678	4.389	29.725	15.252	11.321
AS	0.521	0.427	0.440	0.386	0.043	0.063	28.894	8.583	15.164	14.090
MK	0.599	0.741	0.555	0.554	0.481	0.396	0.277	33.215	15.559	11.861
MC	0.657	0.657	0.597	0.565	0.256	0.246	0.632	0.567	22.667	12.821
EI	0.709	0.583	0.657	0.585	0.210	0.218	0.657	0.516	0.675	15.930

Note. Variances are on the diagonal, covariances are shown above the diagonal, and intercorrelations are shown below the diagonal.

Table 16. Total Sample Variances-Covariances and Intercorrelations for Form 13b

	Subtest									
	GS	AR	WK	PC	NO	CS	AS	MK	MC	EI
GS	27.330	20.992	27.878	11.479	13.136	19.025	15.104	18.394	16.517	15.306
AR	0.632	40.333	27.902	13.001	27.738	34.885	15.280	26.721	20.030	15.186
WK	0.780	0.642	46.767	16.371	19.789	31.299	16.994	21.932	19.728	18.401
PC	0.701	0.653	0.764	9.823	10.844	15.963	7.328	10.139	8.819	7.683
NO	0.286	0.498	0.330	0.394	77.014	74.654	2.897	25.021	11.388	7.906
CS	0.280	0.423	0.352	0.392	0.655	168.795	6.083	30.705	17.296	12.624
AS	0.535	0.446	0.460	0.433	0.061	0.087	29.123	9.370	16.203	14.602
MK	0.606	0.724	0.552	0.557	0.491	0.407	0.299	33.750	16.053	12.455
MC	0.664	0.663	0.606	0.591	0.273	0.280	0.631	0.580	22.661	13.069
EI	0.720	0.588	0.662	0.603	0.222	0.239	0.665	0.527	0.675	16.537

Note. Variances are on the diagonal, covariances are shown above the diagonal, and intercorrelations are shown below the diagonal.

Table 17. Total Sample Variances-Covariances and Intercorrelations for Form 13c(8a)

	Subtest									
	GS	AR	WK	PC	NO	CS	AS	MK	MC	EI
GS	19.627	17.598	19.777	7.138	9.896	14.125	14.068	13.730	14.503	12.290
AR	0.616	41.641	23.287	10.393	25.892	31.906	15.908	26.681	20.171	14.314
WK	0.740	0.598	36.429	11.605	16.460	24.470	16.214	17.709	16.599	15.027
PC	0.589	0.589	0.703	7.481	9.506	13.462	5.795	7.895	6.612	5.460
NO	0.255	0.459	0.312	0.397	76.482	70.333	4.2[illegible]	24.159	8.478	6.133
CS	0.249	0.387	0.317	0.385	0.629	163.534	8.097	29.385	14.211	9.624
AS	0.612	0.478	0.518	0.408	0.094	0.122	26.921	9.011	18.365	14.169
MK	0.556	0.742	0.527	0.518	0.496	0.413	0.312	31.017	14.220	10.030
MC	0.644	0.615	0.541	0.476	0.191	0.219	0.696	0.502	25.826	13.431
EI	0.715	0.572	0.642	0.515	0.181	0.194	0.704	0.464	0.681	15.045

Note. Variances are on the diagonal, covariances are shown above the diagonal, and intercorrelations are shown below the diagonal.

The remaining nine differences between the forms in the squared correlations were found on five different subtest pairs. Differences in the squared correlations involving WK and EI were found between Forms 12a and 13a (0.101), Forms 12a and 13b (0.108), Forms 12b and 13a (0.102), and Forms 12b and 13b (0.109). Differences in the amount of variance accounted for in describing the relationship between MC and MK were found between Forms 12a and 13c (0.116) and Forms 12b and 13c (0.123). Between Forms 11b and 13c, there was a difference of 11.1% in the amount of variance accounted for in the relationship between WK and MC. Between Forms 11b and 12a, the squared correlations involving NO and AR differed by 0.113. Between Forms 13a and 13c, the squared correlations involving GS and AS differed by 0.103.

Conclusions

Differences in the amount of variance explained in the relationships between pairs of subtests occurred on all forms. However, a great number of these differences were associated with Form 13c, the reference form. Also, squared correlations involving PC and other subtests were more likely to show differences between the forms. However, there were only 19 instances out of a possible 945 ([7!/(5!2!)] * [(10*10-10)/2]) where the differences in squared correlations were greater than 0.100.

Factor Analyses

Factor analyses were used to describe the subtest score structure in the seven forms of the ASVAB. Factor structures of the forms were compared in the total, male, and female samples. Similar factor structure among forms would be supportive of the parallelism of the forms, and similar factor structures in the forms in the male and female samples would be further evidence of the comparability of the forms between sexes.

Procedure

For each form, a principal axes factor analysis was performed on the subtest intercorrelation matrix with squared multiple correlations in the diagonal. The solution was rotated orthogonally (using the Varimax procedure) and obliquely (using the Oblimin procedure) to improve interpretability of the factor structure. Separate factor analyses were performed on the subtest correlation matrix of each form in the total, male, and female samples.

Results

Although both orthogonal and oblique rotations were applied to the factor analytic solutions, discussion of the results will be confined to the orthogonal interpretations. The orthogonal solutions were more interpretable and conformed more closely to simple structure than did the oblique solutions. Tables 18 through 38 show the orthogonal solutions for the analyses of the subtest correlations. Four factors were extracted in each of the seven ASVAB forms. Factor loadings of 0.60 or more were used to describe the factor.

Total Sample. Tables 18 through 24 contain the factor loadings from the Varimax rotations for the total sample. Table 18 describes the results from the factor analysis of the Form 11a subtest correlation matrix. The first factor, accounting for 70.3% of the variance, could be described as a technical information factor because the subtests that loaded heavily on it were AS, EI, and MC. WK, GS, and PC loaded heavily on the second factor, accounting for 16.2% of the variance. The two speeded subtests loaded heavily on the third factor. AR and MK loaded heavily on the fourth factor. The four factors accounted for 96.9% of the common variance.

The four factors described in the factor analysis of Form 11a's correlation matrix were extracted in the same order in the factor analyses of Forms 11b, 12a, 12b, and 13c. For Forms 13a and 13b, the first two factors were reversed, although the factor content remained the same. In the total sample, the Varimax-rotated four-factor solutions accounted for over 96% of the common variance on every form.

Table 18. Total Sample Factor Analysis of ASVAB Subtests for Form 11a Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.43	0.70	0.14	0.34
Arithmetic Reasoning	0.38	0.37	0.33	0.65
Word Knowledge	0.36	0.79	0.20	0.23
Paragraph Comprehension	0.27	0.68	0.34	0.26
Numerical Operations	0.04	0.13	0.80	0.25
Coding Speed	0.05	0.17	0.77	0.10
Auto and Shop Information	0.83	0.21	0.00	0.09
Mathematics Knowledge	0.21	0.32	0.32	0.73
Mechanical Comprehension	0.66	0.33	0.16	0.37
Electronics Information	0.70	0.38	0.08	0.25

Table 19. Total Sample Factor Analysis of ASVAB Subtests for Form 11b Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.45	0.66	0.13	0.36
Arithmetic Reasoning	0.39	0.36	0.32	0.64
Word Knowledge	0.39	0.78	0.16	0.24
Paragraph Comprehension	0.26	0.66	0.35	0.22
Numerical Operations	0.00	0.11	0.79	0.23
Coding Speed	0.07	0.17	0.76	0.11
Auto and Shop Information	0.83	0.21	-0.01	0.09
Mathematics Knowledge	0.21	0.30	0.33	0.73
Mechanical Comprehension	0.67	0.33	0.14	0.37
Electronics Information	0.71	0.37	0.07	0.25

Table 20. Total Sample Factor Analysis of ASVAB Subtests for Form 12a Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.49	0.67	0.13	0.31
Arithmetic Reasoning	0.35	0.30	0.38	0.68
Word Knowledge	0.37	0.75	0.19	0.23
Paragraph Comprehension	0.28	0.62	0.39	0.25
Numerical Operations	0.04	0.12	0.78	0.28
Coding Speed	0.05	0.16	0.74	0.10
Auto and Shop Information	0.83	0.22	-0.00	0.10
Mathematics Knowledge	0.25	0.30	0.33	0.73
Mechanical Comprehension	0.67	0.32	0.16	0.39
Electronics Information	0.75	0.31	0.10	0.24

Table 21. Total Sample Factor Analysis of ASVAB Subtests for Form 12b Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.47	0.66	0.14	0.32
Arithmetic Reasoning	0.36	0.32	0.37	0.65
Word Knowledge	0.33	0.79	0.20	0.24
Paragraph Comprehension	0.36	0.63	0.34	0.23
Numerical Operations	0.03	0.12	0.80	0.27
Coding Speed	0.05	0.16	0.75	0.10
Auto and Shop Information	0.83	0.23	-0.01	0.11
Mathematics Knowledge	0.25	0.31	0.34	0.73
Mechanical Comprehension	0.66	0.34	0.16	0.39
Electronics Information	0.74	0.33	0.09	0.24

Table 22. Total Sample Factor Analysis of ASVAB Subtests for Form 13a Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.70	0.43	0.12	0.31
Arithmetic Reasoning	0.37	0.36	0.35	0.63
Word Knowledge	0.81	0.31	0.18	0.24
Paragraph Comprehension	0.68	0.28	0.33	0.23
Numerical Operations	0.12	0.02	0.79	0.23
Coding Speed	0.16	0.05	0.75	0.10
Auto and Shop Information	0.21	0.82	-0.02	0.08
Mathematics Knowledge	0.33	0.20	0.34	0.71
Mechanical Comprehension	0.34	0.65	0.15	0.38
Electronics Information	0.46	0.67	0.11	0.25

Table 23. Total Sample Factor Analysis of ASVAB Subtests for Form 13b Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.68	0.44	0.13	0.33
Arithmetic Reasoning	0.39	0.37	0.36	0.60
Word Knowledge	0.80	0.32	0.21	0.22
Paragraph Comprehension	0.69	0.31	0.30	0.25
Numerical Operations	0.13	0.02	0.80	0.25
Coding Speed	0.18	0.06	0.77	0.10
Auto and Shop Information	0.23	0.81	-0.01	0.09
Mathematics Knowledge	0.32	0.21	0.34	0.70
Mechanical Comprehension	0.34	0.64	0.16	0.39
Electronics Information	0.46	0.67	0.11	0.26

Table 24. Total Sample Factor Analysis of ASVAB Subtests for Form 13c Varimax Rotation

Subtest	Factor loading I	II	III	IV
General Science	0.57	0.53	0.12	0.31
Arithmetic Reasoning	0.40	0.31	0.31	0.66
Word Knowledge	0.40	0.76	0.19	0.22
Paragraph Comprehension	0.29	0.63	0.32	0.25
Numerical Operations	0.02	0.13	0.79	0.24
Coding Speed	0.08	0.15	0.75	0.12
Auto and Shop Information	0.84	0.21	0.03	0.08
Mathematics Knowledge	0.23	0.27	0.36	0.70
Mechanical Comprehension	0.75	0.21	0.11	0.33
Electronics Information	0.73	0.37	0.08	0.22

Males. Tables 25 through 31 summarize the results of the factor analyses and orthogonal rotations of the subtest correlations in the male sample. Four factors were extracted and the results were similar to those of the total sample. In each form, over 96% of the variance in the subtest scores was accounted for by the solutions. The interpretations of the four factors

Table 25. Male Sample Factor Analysis of ASVAB Subtests for Form 11a Varimax Rotation

Subtest	Factor loading I	II	III	IV
General Science	0.71	0.41	0.16	0.34
Arithmetic Reasoning	0.35	0.37	0.35	0.66
Word Knowledge	0.77	0.39	0.19	0.24
Paragraph Comprehension	0.66	0.30	0.34	0.27
Numerical Operations	0.15	0.05	0.79	0.25
Coding Speed	0.16	0.12	0.76	0.12
Auto and Shop Information	0.24	0.80	0.06	0.09
Mathematics Knowledge	0.33	0.18	0.34	0.74
Mechanical Comprehension	0.35	0.63	0.20	0.39
Electronics Information	0.41	0.67	0.11	0.27

Table 26. Male Sample Factor Analysis of ASVAB Subtests for Form 11b Varimax Rotation

Subtest	Factor loading I	II	III	IV
General Science	0.43	0.67	0.14	0.36
Arithmetic Reasoning	0.37	0.35	0.34	0.65
Word Knowledge	0.41	0.77	0.16	0.25
Paragraph Comprehension	0.30	0.65	0.34	0.24
Numerical Operations	0.02	0.11	0.78	0.24
Coding Speed	0.13	0.17	0.75	0.12
Auto and Shop Information	0.80	0.24	0.05	0.09
Mathematics Knowledge	0.19	0.30	0.35	0.74
Mechanical Comprehension	0.65	0.34	0.18	0.39
Electronics Information	0.68	0.40	0.11	0.27

Table 27. Male Sample Factor Analysis of ASVAB Subtests for Form 12a Varimax Rotation

Subtest	Factor loading I	II	III	IV
General Science	0.47	0.68	0.16	0.31
Arithmetic Reasoning	0.34	0.29	0.39	0.68
Word Knowledge	0.42	0.73	0.18	0.24
Paragraph Comprehension	0.31	0.60	0.38	0.26
Numerical Operations	0.04	0.14	0.78	0.28
Coding Speed	0.13	0.15	0.73	0.12
Auto and Shop Information	0.80	0.25	0.06	0.11
Mathematics Knowledge	0.23	0.31	0.34	0.73
Mechanical Comprehension	0.63	0.34	0.20	0.41
Electronics Information	0.72	0.33	0.14	0.25

Table 28. Male Sample Factor Analysis of ASVAB Subtests for Form 12b Varimax Rotation

Subtest	Factor loading I	II	III	IV
General Science	0.45	**0.67**	0.16	0.33
Arithmetic Reasoning	0.35	0.30	0.38	**0.66**
Word Knowledge	0.38	**0.78**	0.19	0.25
Paragraph Comprehension	0.38	**0.60**	0.34	0.24
Numerical Operations	0.04	0.13	**0.79**	0.28
Coding Speed	0.12	0.15	**0.74**	0.12
Auto and Shop Information	**0.80**	0.26	0.05	0.11
Mathematics Knowledge	0.22	0.32	0.35	**0.74**
Mechanical Comprehension	**0.62**	0.36	0.21	0.41
Electronics Information	**0.71**	0.35	0.13	0.26

Table 29. Male Sample Factor Analysis of ASVAB Subtests for Form 13a Varimax Rotation

Subtest	Factor loading I	II	III	IV
General Science	**0.72**	0.39	0.14	0.32
Arithmetic Reasoning	0.37	0.36	0.36	**0.64**
Word Knowledge	**0.80**	0.32	0.18	0.25
Paragraph Comprehension	**0.67**	0.32	0.32	0.24
Numerical Operations	0.13	0.03	**0.79**	0.24
Coding Speed	0.16	0.12	**0.75**	0.12
Auto and Shop Information	0.26	**0.78**	0.03	0.09
Mathematics Knowledge	0.34	0.17	0.35	**0.71**
Mechanical Comprehension	0.37	**0.61**	0.19	0.41
Electronics Information	0.49	**0.62**	0.15	0.26

Table 30. Male Sample Factor Analysis of ASVAB Subtests for Form 13b Varimax Rotation

Subtest	Factor loading			
	I	II	III	IV
General Science	0.70	0.40	0.15	0.34
Arithmetic Reasoning	0.38	0.35	0.37	0.61
Word Knowledge	0.79	0.34	0.21	0.23
Paragraph Comprehension	0.67	0.34	0.29	0.26
Numerical Operations	0.14	0.02	0.80	0.25
Coding Speed	0.17	0.14	0.76	0.12
Auto and Shop Information	0.28	0.77	0.05	0.10
Mathematics Knowledge	0.33	0.18	0.35	0.71
Mechanical Comprehension	0.37	0.59	0.21	0.42
Electronics Information	0.48	0.64	0.15	0.28

Table 31. Male Sample Factor Analysis of ASVAB Subtests for Form 13c Varimax Rotation

Subtest	Factor loading			
	I	II	III	IV
General Science	0.55	0.54	0.14	0.32
Arithmetic Reasoning	0.38	0.31	0.33	0.67
Word Knowledge	0.41	0.76	0.19	0.23
Paragraph Comprehension	0.33	0.62	0.30	0.26
Numerical Operations	0.04	0.14	0.78	0.26
Coding Speed	0.15	0.14	0.75	0.13
Auto and Shop Information	0.81	0.25	0.08	0.10
Mathematics Knowledge	0.23	0.26	0.36	0.71
Mechanical Comprehension	0.73	0.22	0.15	0.34
Electronics Information	0.69	0.42	0.12	0.24

were the same in the total and male samples: technical information, comprehension of verbal material, speededness, and quantitative aptitude. The third and fourth factors extracted were always speeded and quantitative factors, respectively. The order of extraction of the first and second factors varied: The technical information factor was first for Forms 11b, 12a, 12b, and 13c; and the verbal comprehension factor was first on the other forms.

Females. Four factors were also extracted in the factor analyses performed on the female sample correlation matrices from the seven ASVAB forms (Tables 32 through 38). In general, the four factors described in the male and total samples were found in the female sample. However, there was a tendency toward lower loadings on the factor defining technical information.

Table 32. Female Sample Factor Analysis of ASVAB Subtests for Form 11a Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.66	0.43	0.35	0.11
Arithmetic Reasoning	0.36	0.40	0.63	0.28
Word Knowledge	0.77	0.41	0.21	0.15
Paragraph Comprehension	0.66	0.30	0.29	0.26
Numerical Operations	0.09	0.05	0.26	0.77
Coding Speed	0.14	0.12	0.08	0.73
Auto and Shop Information	0.29	0.74	0.11	0.09
Mathematics Knowledge	0.28	0.19	0.74	0.29
Mechanical Comprehension	0.33	0.54	0.39	0.16
Electronics Information	0.31	0.62	0.24	0.08

Table 33. Female Sample Factor Analysis of ASVAB Subtests for Form 11b Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.47	0.61	0.38	0.11
Arithmetic Reasoning	0.40	0.35	0.63	0.27
Word Knowledge	0.44	0.75	0.26	0.08
Paragraph Comprehension	0.31	0.64	0.23	0.30
Numerical Operations	0.03	0.09	0.21	0.74
Coding Speed	0.13	0.11	0.09	0.71
Auto and Shop Information	0.74	0.30	0.12	0.07
Mathematics Knowledge	0.21	0.26	0.74	0.28
Mechanical Comprehension	0.56	0.31	0.42	0.17
Electronics Information	0.61	0.29	0.26	0.11

Table 34. Female Sample Factor Analysis of ASVAB Subtests for Form 12a Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.47	0.64	0.33	0.09
Arithmetic Reasoning	0.37	0.31	0.67	0.33
Word Knowledge	0.37	0.74	0.23	0.13
Paragraph Comprehension	0.30	0.62	0.23	0.34
Numerical Operations	0.05	0.11	0.30	0.75
Coding Speed	0.10	0.12	0.07	0.70
Auto and Shop Information	0.71	0.29	0.16	0.08
Mathematics Knowledge	0.25	0.27	0.75	0.27
Mechanical Comprehension	0.56	0.30	0.42	0.16
Electronics Information	0.61	0.34	0.26	0.12

Table 35. Female Sample Factor Analysis of ASVAB Subtests for Form 12b Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.62	0.48	0.32	0.10
Arithmetic Reasoning	0.31	0.37	0.64	0.35
Word Knowledge	0.79	0.37	0.23	0.13
Paragraph Comprehension	0.65	0.31	0.24	0.28
Numerical Operations	0.10	0.03	0.28	0.76
Coding Speed	0.11	0.11	0.08	0.70
Auto and Shop Information	0.29	0.73	0.16	0.07
Mathematics Knowledge	0.29	0.24	0.73	0.31
Mechanical Comprehension	0.32	0.54	0.39	0.16
Electronics Information	0.34	0.62	0.22	0.12

Table 36. Female Sample Factor Analysis of ASVAB Subtests for Form 13a Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.67	0.34	0.41	0.06
Arithmetic Reasoning	0.33	0.69	0.30	0.30
Word Knowledge	0.81	0.25	0.33	0.10
Paragraph Comprehension	0.66	0.30	0.27	0.29
Numerical Operations	0.11	0.25	0.02	0.75
Coding Speed	0.09	0.10	0.13	0.71
Auto and Shop Information	0.24	0.13	0.65	0.07
Mathematics Knowledge	0.28	0.72	0.16	0.28
Mechanical Comprehension	0.34	0.44	0.46	0.16
Electronics Information	0.44	0.28	0.60	0.14

Table 37. Female Sample Factor Analysis of ASVAB Subtests for Form 13b Varimax Rotation

	Factor loading			
Subtest	I	II	III	IV
General Science	0.66	0.42	0.12	0.33
Arithmetic Reasoning	0.40	0.31	0.32	0.62
Word Knowledge	0.80	0.32	0.18	0.24
Paragraph Comprehension	0.68	0.30	0.24	0.27
Numerical Operations	0.12	0.06	0.78	0.25
Coding Speed	0.14	0.09	0.74	0.10
Auto and Shop Information	0.27	0.65	0.06	0.12
Mathematics Knowledge	0.29	0.20	0.30	0.71
Mechanical Comprehension	0.34	0.53	0.16	0.39
Electronics Information	0.49	0.55	0.13	0.27

Table 38. Female Sample Factor Analysis of ASVAB Subtests for Form 13c Varimax Rotation

Subtest	Factor loading I	II	III	IV
General Science	0.57	0.33	0.48	0.09
Arithmetic Reasoning	0.38	0.68	0.27	0.28
Word Knowledge	0.47	0.24	0.73	0.13
Paragraph Comprehension	0.30	0.29	0.60	0.26
Numerical Operations	0.04	0.24	0.11	0.75
Coding Speed	0.14	0.10	0.10	0.69
Auto and Shop Information	0.73	0.12	0.23	0.11
Mathematics Knowledge	0.21	0.62	0.24	0.31
Mechanical Comprehension	0.57	0.42	0.20	0.10
Electronics Information	0.67	0.27	0.29	0.12

Conclusions

The factor analyses of the subtest correlations revealed similar structures across the seven ASVAB forms in the total, male, and female samples. Four factors were extracted, accounting for 96% of the variance in each of the Varimax-rotated solutions. AS, MC, and EI tended to load heavily on a technical information factor. WK, GS, and PC loaded on a comprehension of verbal material factor. NO and CS subtests loaded on a speededness factor, and AR and MK loaded on a quantitative ability factor.

Summary and Conclusions for Subtest Summary Statistics

Using the descriptive summary statistics calculated on subtest scores, the parallelism of the new forms was evaluated for the total sample, and then for the male and female samples. In each of the three sets of analyses--total, male, and female--there was evidence that the subtest and AFQT scores on Form 12a tended to be lower than scores on the other forms. There was little evidence of a systematic sex-by-form interaction, however.

Subtest reliabilities were consistent across the new forms in the total and male samples. In the female sample, the reliabilities were more variable across the new forms, but were nevertheless very consistent, except for AS. There was no evidence of a sex-by-form effect on subtest reliabilities. The subtest reliability comparisons supported the comparability of the forms.

In the total sample, the range of the estimates of SEM across the new forms was less than 0.07--except for the PC subtest, which showed a difference in SEM of 0.125 between Forms 12a and 12b. Similar patterns were seen in the male and female samples. There was no differential sex-by-form effect.

The interrelationships of the subtests were compared across forms in the total, male, and female samples. There were no form-related differences in the total sample. There were sex-related differences in the interrelationships of the subtests, with males tending to show higher subtest intercorrelations. There was no evidence of sex-by-form interactions in the correlations. It was concluded that the correlational structures of the forms were comparable.

The factor analytic results supported a comparable structure among the subtests in the total, male, and female samples. Four factors were extracted: a verbal comprehension factor, a technical information factor, a speededness factor, and a quantitative ability factor. The primary differences between the results in the male and female samples were the lower factor loadings on the technical information factor in the female sample. The subtest factor structure was judged to be comparable across forms.

V. ITEM ANALYSES

Item statistics were calculated for items in the total, male, and female samples. The purpose of the item analyses was to identify differences in item responses in the subtests across forms and across sexes within forms. Both classical and Item Response Theory (IRT) analyses were performed.

Classical Analyses

Procedure

Classical item statistics were computed for each item. These statistics included the proportion of examinees responding correctly to the item, and the point-biserial and biserial correlations between the scored item response and the total subtest score. The statistics were averaged for each subtest within each form for the total, male, and female samples. The results are summarized in Tables 39, 40, and 41 for the total, male, and female samples, respectively.

Results

Total Sample. The average mean proportion correct across the new forms ranged from 0.513 for MK to 0.738 for PC. For seven of the ten subtests, the range in mean proportion correct across the new forms was less than 0.027. A greater variability in mean proportion correct across the new forms was found for PC (0.085), NO (0.073), and EI)0.05). For each subtest, the average mean proportion correct across forms was within 0.04 of the mean proportion correct for the corresponding reference subtest.

Within a subtest, the estimates of average biserial item-total correlations were quite consistent across the new forms, with differences generally below 0.05. The estimates of biserial item-total correlation for PC were more variant, however. The mean biserial item-total correlations averaged for the new forms ranged from a low of 0.566 on EI and MC to a high of 0.696 on WK and PC. The new forms' average mean biserial item-total correlations were higher than those of the reference test, with the exception of MC, which was 0.004 lower. In general, the average mean biserial item-total correlation for the new forms was similar to that found in the like-named reference subtest. The largest differences occurred on GS (0.073) and PC (0.059).

Table 39. Total Sample Classical Item Statistic Means

Statistic	Form Number						
	11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
Difficulty	0.647	0.646	0.668	0.670	0.660	0.654	0.637
Biserial	0.628	0.624	0.627	0.621	0.632	0.638	0.555
Point-biser.	0.460	0.458	0.443	0.437	0.465	0.471	0.405
Arithmetic Reasoning							
Difficulty	0.627	0.622	0.634	0.634	0.643	0.638	0.594
Biserial	0.653	0.638	0.634	0.653	0.617	0.617	0.613
Point-biser.	0.493	0.484	0.476	0.494	0.461	0.464	0.464
Word Knowledge							
Difficulty	0.725	0.722	0.723	0.726	0.719	0.736	0.761
Biserial	0.701	0.678	0.716	0.694	0.683	0.702	0.667
Point-biser.	0.488	0.465	0.491	0.481	0.472	0.478	0.441
Paragraph Comprehension							
Difficulty	0.749	0.724	0.691	0.776	0.752	0.735	0.753
Biserial	0.696	0.673	0.662	0.722	0.724	0.697	0.637
Point-biser.	0.487	0.484	0.481	0.492	0.505	0.493	0.445
Numerical Operations							
Difficulty	0.747	0.767	0.694	0.715	0.743	0.725	0.772
Coding Speed							
Difficulty	0.592	0.593	0.596	0.600	0.594	0.603	0.585
Auto and Shop Information							
Difficulty	0.627	0.623	0.604	0.610	0.630	0.629	0.618
Biserial	0.621	0.618	0.622	0.622	0.606	0.607	0.582
Point-biser.	0.477	0.475	0.477	0.476	0.462	0.463	0.444
Mathematics Knowledge							
Difficulty	0.517	0.513	0.503	0.504	0.522	0.520	0.527
Biserial	0.633	0.633	0.678	0.679	0.630	0.636	0.610
Point-biser.	0.491	0.493	0.526	0.527	0.486	0.490	0.470
Mechanical Comprehension							
Difficulty	0.607	0.611	0.612	0.614	0.617	0.611	0.603
Biserial	0.555	0.557	0.556	0.556	0.556	0.554	0.560
Point-biser.	0.420	0.421	0.421	0.421	0.418	0.417	0.430
Electronics Information							
Difficulty	0.580	0.592	0.624	0.630	0.609	0.600	0.595
Biserial	0.560	0.562	0.563	0.560	0.571	0.579	0.560
Point-biser.	0.429	0.429	0.431	0.427	0.432	0.439	0.423

Table 40. Male Sample Classical Item Statistic Means

Statistic	Form number 11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
Difficulty	0.655	0.653	0.678	0.680	0.671	0.666	0.648
Biserial	0.639	0.633	0.640	0.635	0.642	0.648	0.568
Point-biser.	0.467	0.463	0.449	0.445	0.470	0.476	0.412
Arithmetic Reasoning							
Difficulty	0.634	0.630	0.638	0.640	0.647	0.644	0.602
Biserial	0.661	0.644	0.641	0.659	0.626	0.623	0.620
Point-biser.	0.499	0.488	0.481	0.497	0.467	0.468	0.469
Word Knowledge							
Difficulty	0.722	0.721	0.721	0.724	0.720	0.735	0.761
Biserial	0.703	0.681	0.719	0.698	0.691	0.706	0.675
Point-biser.	0.492	0.467	0.494	0.484	0.477	0.481	0.445
Paragraph Comprehension							
Difficulty	0.745	0.717	0.687	0.777	0.748	0.733	0.747
Biserial	0.700	0.673	0.664	0.729	0.727	0.700	0.638
Point-biser.	0.493	0.486	0.485	0.498	0.509	0.496	0.448
Numerical Operations							
Difficulty	0.737	0.754	0.685	0.705	0.734	0.716	0.760
Coding Speed							
Difficulty	0.577	0.578	0.582	0.585	0.580	0.589	0.570
Auto and Shop Information							
Difficulty	0.665	0.660	0.642	0.648	0.669	0.667	0.653
Biserial	0.615	0.611	0.615	0.616	0.603	0.604	0.581
Point-biser.	0.464	0.462	0.464	0.462	0.451	0.452	0.437
Mathematics Knowledge							
Difficulty	0.521	0.515	0.506	0.509	0.524	0.523	0.526
Biserial	0.641	0.642	0.684	0.685	0.637	0.643	0.615
Point-biser.	0.497	0.500	0.531	0.532	0.491	0.495	0.474
Mechanical Comprehension							
Difficulty	0.628	0.631	0.633	0.636	0.638	0.632	0.629
Biserial	0.558	0.559	0.558	0.559	0.562	0.560	0.564
Point-biser.	0.419	0.418	0.420	0.419	0.418	0.418	0.429
Electronics Information							
Difficulty	0.602	0.614	0.648	0.655	0.631	0.623	0.620
Biserial	0.568	0.570	0.567	0.565	0.576	0.584	0.564
Point-biser.	0.432	0.432	0.430	0.425	0.431	0.438	0.421

Table 41. Female Sample Classical Item Statistic Means

Statistic	Form number 11a	11b	12a	12b	13a	13b	13c(8a)
General Science							
Difficulty	0.606	0.606	0.612	0.615	0.598	0.593	0.583
Biserial	0.575	0.582	0.564	0.550	0.579	0.582	0.490
Point-biser.	0.420	0.427	0.400	0.390	0.430	0.434	0.360
Arithmetic Reasoning							
Difficulty	0.593	0.582	0.610	0.599	0.622	0.606	0.553
Biserial	0.611	0.601	0.599	0.626	0.571	0.578	0.573
Point-biser.	0.463	0.457	0.449	0.477	0.425	0.437	0.433
Word Knowledge							
Difficulty	0.740	0.724	0.737	0.740	0.715	0.741	0.756
Biserial	0.691	0.661	0.702	0.679	0.650	0.683	0.639
Point-biser.	0.470	0.451	0.473	0.461	0.445	0.461	0.429
Paragraph Comprehension							
Difficulty	0.772	0.761	0.716	0.774	0.776	0.744	0.780
Biserial	0.658	0.664	0.639	0.687	0.702	0.681	0.631
Point-biser.	0.446	0.461	0.455	0.459	0.483	0.472	0.425
Numerical Operations							
Difficulty	0.799	0.832	0.742	0.768	0.796	0.778	0.827
Coding Speed							
Difficulty	0.668	0.671	0.672	0.677	0.667	0.678	0.654
Auto and Shop Information							
Difficulty	0.426	0.419	0.396	0.405	0.422	0.424	0.449
Biserial	0.461	0.452	0.449	0.454	0.378	0.390	0.431
Point-biser.	0.355	0.348	0.349	0.352	0.290	0.300	0.327
Mathematics Knowledge							
Difficulty	0.496	0.503	0.489	0.478	0.508	0.504	0.529
Biserial	0.590	0.588	0.650	0.649	0.594	0.602	0.584
Point-biser.	0.457	0.457	0.497	0.496	0.457	0.462	0.447
Mechanical Comprehension							
Difficulty	0.496	0.504	0.499	0.498	0.501	0.500	0.476
Biserial	0.465	0.485	0.466	0.461	0.439	0.445	0.452
Point-biser.	0.359	0.373	0.359	0.354	0.338	0.342	0.351
Electronics Information							
Difficulty	0.464	0.474	0.489	0.494	0.487	0.479	0.472
Biserial	0.440	0.446	0.441	0.435	0.460	0.478	0.458
Point-biser.	0.338	0.344	0.345	0.339	0.357	0.371	0.352

There was no evidence of a sex-by-form interaction. For seven of the ten subtests, the highest mean proportion correct and the lowest mean proportion correct occurred on the same form for both males and females.

Males and Females. Males had higher average mean proportions correct than did females on six of the ten subtests. The male mean proportions correct on the new forms ranged from 0.516 for MK to 0.734 for PC. The female mean proportions correct ranged from 0.415 on AS to 0.757 on PC. There was no evidence of a sex-by-form interaction. For seven of the ten subtests, the highest mean proportion correct and the lowest mean proportion correct occurred on the same form for both males and females.

In the male sample, the average biserial correlation for the new forms ranged from a low of 0.559 on MC to a high of 0.700 on WK. In the female sample, the average biserial correlation for the new forms ranged from a low of 0.431 on AS to a high of 0.678 on WK. For every new subtest, the average biserial correlation was greater in the male sample.

Sex differences appeared to be fairly consistent across the new forms. The average subtest difference between average biserial correlations in the male and female samples was highest on Form 13a (0.086) and lowest on 11b (0.067). Thus, the largest average sex difference between forms was 0.019.

Aberrant Items

For the total sample, only one of the items analyzed had an incorrect alternative with a greater point-biserial item-total correlation than its correct alternative. This item, in the Form 12a and 12b AS subtests, showed a similar aberration when the items were analyzed in the development study. At that time, the item also had a negative point-biserial correlation between responses to the keyed alternative and the total subtest score. In this study, the point-biserial item-total correlation for the correct response was positive but low (0.097 on 12a, 0.124 on 12b). A similar result was noted in the male sample only for Form 12b.

In the female sample, one AS item in each of the three new forms had higher point-biserial correlations for an incorrect rather than for the correct response. In each set of parallel forms (11a and 11b, for example), the problem was caused by the same item. All three of the items were keyed correctly and had clearly incorrect distractors. Also, Forms 11a, 11b, 12a, and 12b each had one MC item with a higher point-biserial correlation associated with an incorrect alternative. Once again, in each set of parallel forms, the problem resulted from the same item. Form 13a had a similarly aberrant item in EI and Form 12a had one in NO. In all cases, the items were keyed correctly and the distractors were incorrect. None of the aberrant items had negative point-biserial correlations for the keyed response.

Conclusions

In the total sample, the average level of mean proportion correct for a particular subtest ranged from 0.513 to 0.738 across forms. For seven of the ten subtests, the mean proportions correct were quite consistent across forms. There was some indication that the mean proportions correct tended to be lower on Form 12a.

Males generally had higher average proportions correct than did females on six of the ten subtests. The average mean proportions correct for males on the new forms ranged from 0.516 to 0.734. There was a greater range in the female sample, with a low of 0.415 and a high of 0.757. There was no evidence of a systematic sex-by-form interaction.

The estimates of biserial item-total correlations for the total sample were quite consistent across the new forms, with differences in biserial correlations generally below 0.05. The average mean biserial item-total correlations for the new forms ranged from 0.566 to 0.696. There was no evidence of a sex-by-form effect on the mean biserial correlations.

Even though there were some indications of differences in mean proportion correct associated with Form 12a, there were, in general, consistent patterns in the estimates of mean difficulties and mean biserial correlations across forms. There was no evidence of any systematic sex-by-form effects.

IRT Analyses

Procedure

IRT parameters were computed using ASCAL, a conditional maximum-likelihood/modal-Bayesian item calibration program for the three-parameter logistic item response model (see Birnbaum, 1968). The basic model and algorithms are similar to those presented by Wood, Wingersky, and Lord (1976). The algorithms used in ASCAL differed from those described by Wood et al. (1976) in the ways described below.

Bayesian prior probabilities were applied to the ability estimates and to the a and c parameters. A standard normal distribution was used to specify the prior probability distribution of examinee ability. For the a parameter, a beta distribution was used with both shape parameters equal to 3.0 and endpoints equal to 0.3 and 2.6. For the c parameter, a beta distribution was used with shape parameters equal to 5.0 and endpoints equal to -0.05 and (2/k)+0.05 where k is the number of alternatives.

The ability estimates were unbounded. The a parameter was bounded between 0.40 and 2.50, the b parameter was bounded between -3.00 and 3.00, and the c parameter was bounded between 0.00 and (2/k).

The estimation process began with the computation of standardized number-correct scores for the examinees and conventional proportion-correct and item-total biserial correlations for the items. These statistics were then transformed into IRT a and b parameters using Jensema's (1976) transformations. Guessing c parameters of 1/k were assigned to the items in this initial stage.

These initial parameter estimates were then used to estimate abilities, and examinees were grouped into 20 fractiles, each containing approximately 5% of the examinees. The fractile means were computed and standardized. The mean (weighted by the number of subjects contained in each fractile) of the means was set to zero, and the variance (also weighted) of the means was set to one. Item parameters were then estimated using the fractile means and frequencies as input data.

The ability and item-parameter estimation process was repeated until the parameter estimates converged or until ten iterations were performed. Statistics describing the distribution of the item parameters on each subtest were summarized by form. Item statistics are discussed below. Graphs of test information functions and test characteristic curves for each subtest within a form in the total, male, and female samples appear in Appendices A and B in Volume II.

Results

Total Sample. Total sample statistics for the a, b, and c parameter estimates are summarized in Tables 42, 45, 48, 51, 54, 57, 60, and 63. The ranges of the mean estimates of the item parameters varied across the new forms. The smallest range in the mean estimate of a occurred on MC (0.074), and the widest range occurred on AS (0.230). On the other hand, the smallest range in the mean b parameter estimates occurred on AS (0.075), and the widest on PC (0.512). Since

the PC items probably did not satisfy the assumption of local independence necessary for the application of IRT, the variability in estimates was not surprising. Excluding PC, the ranges across the new forms for the mean b parameters were less than 0.21. Again excluding PC, the ranges across the new forms of the mean c parameter estimates were less than 0.05. There was no evidence of a systematic form bias.

Males. Results of item calibration in the male sample are summarized in Tables 43, 46, 49, 52, 55, 58, 61, and 64. The ranges across the new forms of the mean estimates for the a parameter were variable. The smallest range occurred on MC (0.088) and the widest on EI (0.301). Typically, the ranges on the subtests were less than 0.23. Similar variability was seen on the mean estimates of the b parameter. Excluding the estimates on the PC subtest, the smallest range occurred on AS (0.092) and the widest on EI (0.294). Typically, the ranges between low and high mean estimates of b were less than 0.2. As in the total sample, the ranges of the mean estimates of the c parameter were less than 0.05, with the exception of the range on PC.

Females. Results of item calibration in the female sample are summarized in Tables 44, 47, 50, 53, 56, 59, 62, and 65. The ranges across the new forms of the mean a values were highest on PC (0.246) and lowest on WK (0.089). The ranges across new forms of the b parameter estimates were wider than in the male or total sample. Recalling that the structure of the PC subtest did not meet IRT assumptions, a range of 0.676 on this subtest is not surprising. Ranges of 0.416 in the estimation of b on the AS and EI subtests were seen.

Table 42. Total Sample IRT Summary Statistics for General Science

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.343	1.319	1.307	1.303	1.253	1.247	1.225
Variance	0.340	0.346	0.268	0.288	0.318	0.269	0.434
Skew	1.069	1.128	0.835	0.909	1.145	1.086	0.832
Kurtosis	-0.281	-0.216	0.002	-0.116	0.173	0.060	-0.653
Minimum	0.699	0.694	0.581	0.609	0.612	0.678	0.574
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.583	0.588	0.517	0.536	0.564	0.518	0.659
b							
Mean	-0.285	-0.285	-0.454	-0.460	-0.364	-0.338	-0.189
Variance	0.990	1.008	1.173	1.183	0.732	0.705	1.447
Skew	0.116	0.120	-0.339	-0.288	0.263	0.312	0.585
Kurtosis	-1.268	-1.226	-0.744	-0.671	-1.144	-1.171	-0.137
Minimum	-1.887	-1.949	-2.908	-2.944	-1.528	-1.463	-1.987
Maximum	1.346	1.366	1.154	1.126	1.041	1.030	3.000
Std. Dev.	0.995	1.004	1.083	1.088	0.856	0.840	1.203
c							
Mean	0.161	0.159	0.185	0.188	0.167	0.164	0.191
Variance	0.017	0.017	0.011	0.010	0.016	0.013	0.015
Skew	0.426	0.419	0.151	0.070	0.475	0.353	0.270
Kurtosis	-1.115	-1.050	0.054	0.063	-0.780	-0.749	-1.093
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.030
Maximum	0.410	0.430	0.440	0.410	0.430	0.420	0.450
Std. Dev.	0.132	0.131	0.103	0.100	0.128	0.114	0.123

Table 43. Male Sample IRT Summary Statistics for General Science

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.355	1.347	1.318	1.305	1.272	1.251	1.252
Variance	0.313	0.347	0.270	0.281	0.325	0.242	0.401
Skew	1.059	0.926	0.914	1.084	1.039	1.029	0.827
Kurtosis	-0.179	-0.606	-0.033	0.325	-0.174	0.140	-0.586
Minimum	0.747	0.725	0.638	0.658	0.598	0.686	0.594
Maximum	2.500	2.500	2.500	2.500	2.490	2.500	2.500
Std. Dev.	0.559	0.589	0.519	0.530	0.570	0.491	0.633
b							
Mean	-0.315	-0.321	-0.492	-0.508	-0.415	-0.386	-0.217
Variance	0.967	0.991	1.126	1.143	0.723	0.693	1.457
Skew	0.035	0.088	-0.263	-0.230	0.289	0.317	0.519
Kurtosis	-1.292	-1.213	-0.883	-0.770	-1.195	-1.243	-0.110
Minimum	-1.928	-2.003	-2.793	-2.886	-1.694	-1.605	-2.044
Maximum	1.288	1.366	1.106	1.076	0.995	0.977	3.000
Std. Dev.	0.983	0.995	1.061	1.069	0.850	0.832	1.207
c							
Mean	0.166	0.161	0.186	0.187	0.172	0.168	0.205
Variance	0.018	0.016	0.008	0.008	0.016	0.012	0.015
Skew	0.401	0.384	-0.362	-0.295	0.426	0.317	0.303
Kurtosis	-1.193	-1.023	-0.380	0.055	-0.926	-0.824	-0.881
Minimum	0.000	0.000	0.010	0.000	0.000	0.000	0.020
Maximum	0.420	0.440	0.360	0.370	0.430	0.410	0.460
Std. Dev.	0.133	0.128	0.091	0.087	0.127	0.111	0.121

Table 44. Female Sample IRT Summary Statistics for General Science

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.393	1.347	1.329	1.211	1.304	1.340	1.138
Variance	0.315	0.285	0.289	0.228	0.265	0.387	0.273
Skew	0.642	0.862	0.927	0.966	0.944	0.832	0.737
Kurtosis	-0.867	-0.168	-0.122	0.505	0.081	-0.793	0.014
Minimum	0.617	0.539	0.618	0.601	0.594	0.584	0.429
Maximum	2.500	2.500	2.500	2.411	2.500	2.500	2.500
Std. Dev.	0.561	0.533	0.538	0.477	0.515	0.622	0.522
b							
Mean	0.110	0.063	-0.098	-0.131	0.178	0.156	0.129
Variance	1.471	1.381	1.891	1.587	1.400	1.413	1.480
Skew	0.468	0.569	-0.080	-0.355	0.868	0.940	0.430
Kurtosis	-0.596	-0.363	-0.449	-0.744	0.432	0.336	-0.941
Minimum	-1.844	-1.954	-3.000	-3.000	-1.624	-1.499	-1.682
Maximum	3.000	3.000	3.000	1.860	3.000	3.000	2.340
Std. Dev.	1.213	1.175	1.375	1.260	1.183	1.189	1.217
c							
Mean	0.224	0.214	0.215	0.211	0.220	0.202	0.207
Variance	0.013	0.011	0.007	0.006	0.009	0.009	0.009
Skew	-0.158	-0.133	-0.057	0.661	0.523	0.319	0.013
Kurtosis	-0.386	-0.020	-0.446	-0.431	-0.444	-0.410	-1.101
Minimum	0.000	0.000	0.040	0.090	0.060	0.030	0.050
Maximum	0.460	0.420	0.370	0.390	0.430	0.410	0.380
Std. Dev.	0.115	0.104	0.081	0.077	0.097	0.092	0.093

Table 45. Total Sample IRT Summary Statistics for Arithmetic Reasoning

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.276	1.259	1.169	1.293	1.198	1.364	1.261
Variance	0.240	0.220	0.234	0.196	0.182	0.331	0.271
Skew	0.561	0.802	0.923	0.986	1.068	0.496	0.953
Kurtosis	-0.578	0.054	0.506	0.872	1.119	-0.794	0.548
Minimum	0.535	0.574	0.428	0.491	0.648	0.421	0.423
Maximum	2.500	2.486	2.500	2.500	2.500	2.500	2.492
Std. Dev.	0.489	0.470	0.483	0.442	0.427	0.575	0.520
b							
Mean	-0.300	-0.252	-0.444	-0.239	-0.341	-0.245	-0.180
Variance	0.814	0.855	1.040	0.595	0.876	0.777	1.100
Skew	-0.852	-0.792	-0.660	-0.220	-0.417	-0.078	-0.883
Kurtosis	0.118	0.622	-0.388	-0.878	-0.963	-1.160	0.259
Minimum	-2.791	-3.000	-2.853	-1.681	-2.161	-1.932	-3.000
Maximum	0.861	1.169	1.068	1.290	0.950	1.327	1.285
Std. Dev.	0.902	0.925	1.020	0.771	0.936	0.882	1.049
c							
Mean	0.146	0.150	0.130	0.164	0.166	0.174	0.162
Variance	0.012	0.016	0.011	0.014	0.011	0.017	0.018
Skew	0.701	0.627	0.814	0.257	0.133	-0.109	0.483
Kurtosis	0.402	0.051	0.470	-0.512	-1.175	-1.559	-0.553
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.460	0.500	0.430	0.460	0.360	0.380	0.500
Std. Dev.	0.109	0.127	0.103	0.119	0.107	0.131	0.136

Table 46. Male Sample IRT Summary Statistics for Arithmetic Reasoning

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.291	1.273	1.179	1.318	1.224	1.391	1.273
Variance	0.256	0.200	0.227	0.216	0.180	0.350	0.279
Skew	0.583	0.630	0.955	0.938	0.894	0.373	0.918
Kurtosis	-0.730	-0.291	0.601	0.626	0.806	-1.025	0.320
Minimum	0.556	0.596	0.444	0.504	0.647	0.415	0.429
Maximum	2.500	2.377	2.500	2.500	2.493	2.500	2.500
Std. Dev.	0.506	0.447	0.476	0.465	0.424	0.592	0.528
b							
Mean	-0.323	-0.265	-0.443	-0.260	-0.347	-0.269	-0.209
Variance	0.767	0.809	0.974	0.590	0.845	0.765	1.047
Skew	-0.761	-0.740	-0.631	-0.198	-0.444	-0.077	-0.882
Kurtosis	-0.115	0.415	-0.443	-0.870	-0.967	-1.162	0.329
Minimum	-2.663	-2.878	-2.736	-1.717	-2.184	-1.976	-3.000
Maximum	0.797	1.130	1.016	1.282	0.886	1.271	1.220
Std. Dev.	0.876	0.900	0.987	0.768	0.919	0.875	1.023
c							
Mean	0.145	0.155	0.135	0.166	0.171	0.176	0.165
Variance	0.011	0.016	0.010	0.014	0.011	0.017	0.018
Skew	0.645	0.648	0.660	0.355	0.046	-0.076	0.419
Kurtosis	0.106	0.037	0.019	-0.258	-1.216	-1.568	-0.653
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.440	0.500	0.410	0.480	0.350	0.370	0.500
Std. Dev.	0.106	0.127	0.100	0.120	0.105	0.131	0.135

Table 47. Female Sample IRT Summary Statistics for Arithmetic Reasoning

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.260	1.200	1.181	1.267	1.157	1.294	1 224
Variance	0.221	0.202	0.271	0.153	0.227	0.218	0.195
Skew	0.710	0.595	0.894	0.753	1.264	0.481	0.278
Kurtosis	0.211	-0.018	0.242	0.689	0.552	-0.812	-0.850
Minimum	0.457	0.400	0.400	0.482	0.608	0.530	0.435
Maximum	2.500	2.270	2.500	2.346	2.308	2.334	2.053
Std. Dev.	0.470	0.450	0.520	0.391	0.477	0.466	0.442
b							
Mean	-0.061	-0.145	-0.256	-0.055	-0.191	-0.032	0.047
Variance	1.220	1.107	1.484	0.595	0.978	0.812	1.359
Skew	-0.163	-0.685	-0.100	-0.300	-0.254	0.183	-0.905
Kurtosis	1.324	0.179	0.598	-0.893	-0.911	-0.837	0.357
Minimum	-3.000	-3.000	-3.000	-1.552	-2.238	-1.486	-3.000
Maximum	3.000	1.465	3.000	1.292	1.370	1.830	1.629
Std. Dev.	1.105	1.052	1.218	0.771	0.989	0.901	1.166
c							
Mean	0.182	0.155	0.170	0.187	0.199	0.201	0.176
Variance	0.012	0.009	0.009	0.012	0.009	0.011	0.016
Skew	0.554	0.520	0.987	-0.108	0.338	0.054	0.567
Kurtosis	0.466	-0.154	1.602	-0.996	-0.804	-0.964	-0.543
Minimum	0.010	0.000	0.010	0.000	0.030	0.010	0.000
Maximum	0.500	0.410	0.480	0.380	0.380	0.400	0.430
Std. Dev.	0.111	0.096	0.096	0.111	0.095	0.105	0.126

Table 48. Total Sample IRT Summary Statistics for Word Knowledge

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.472	1.528	1.588	1.516	1.554	1.557	1.358
Variance	0.239	0.272	0.288	0.189	0.181	0.314	0.369
Skew	0.741	0.208	0.501	0.486	0.461	0.293	0.870
Kurtosis	-0.126	-0.755	-1.106	0.482	-0.167	-0.981	-0.545
Minimum	0.651	0.601	0.825	0.501	0.830	0.594	0.605
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.489	0.522	0.537	0.435	0.425	0.561	0.607
b							
Mean	-0.576	-0.562	-0.580	-0.547	-0.521	-0.661	-0.869
Variance	0.805	1.066	1.006	0.932	1.043	1.142	1.330
Skew	-0.228	-0.390	-0.123	-0.363	-0.372	-0.456	-0.060
Kurtosis	-0.926	-0.800	-0.871	-0.436	-0.867	-0.872	-1.066
Minimum	-2.278	-3.000	-2.345	-3.000	-2.660	-3.000	-3.000
Maximum	0.994	1.243	1.250	1.037	1.398	0.995	0.970
Std. Dev.	0.897	1.033	1.003	0.965	1.021	1.068	1.153
c							
Mean	0.218	0.243	0.209	0.253	0.238	0.231	0.235
Variance	0.014	0.017	0.013	0.016	0.013	0.009	0.016
Skew	-0.383	-0.055	0.137	-0.095	-0.096	-0.495	0.014
Kurtosis	-0.623	-0.894	-0.584	-0.543	-0.396	-0.513	-0.817
Minimum	0.000	0.010	0.000	0.000	0.030	0.030	0.010
Maximum	0.430	0.500	0.460	0.500	0.490	0.400	0.500
Std. Dev.	0.117	0.131	0.113	0.125	0.112	0.093	0.127

Average of new forms

Table 49. Male Sample IRT Summary Statistics for Word Knowledge

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.487	1.532	1.593	1.540	1.559	1.580	1.378
Variance	0.232	0.266	0.281	0.201	0.186	0.327	0.356
Skew	0.709	0.229	0.456	0.532	0.494	0.239	0.831
Kurtosis	-0.153	-0.622	-1.111	0.315	-0.292	-1.119	-0.594
Minimum	0.664	0.631	0.834	0.531	0.873	0.607	0.610
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.482	0.515	0.530	0.449	0.431	0.572	0.597
b							
Mean	-0.556	-0.556	-0.564	-0.533	-0.532	-0.648	-0.860
Variance	0.786	1.053	0.981	0.923	1.009	1.138	1.314
Skew	-0.287	-0.357	-0.100	-0.346	-0.300	-0.439	-0.011
Kurtosis	-0.925	-0.830	-0.861	-0.427	-0.881	-0.875	-1.110
Minimum	-2.264	-3.000	-2.330	-3.000	-2.583	-3.000	-3.000
Maximum	0.979	1.207	1.273	1.069	1.438	0.980	0.967
Std. Dev.	0.886	1.026	0.990	0.961	1.004	1.067	1.146
c							
Mean	0.220	0.241	0.208	0.249	0.231	0.230	0.235
Variance	0.013	0.016	0.013	0.014	0.011	0.008	0.015
Skew	-0.431	-0.002	0.087	-0.127	-0.018	-0.435	0.076
Kurtosis	-0.647	-0.785	-0.720	-0.496	-0.390	-0.459	-0.727
Minimum	0.000	0.010	0.000	0.000	0.040	0.030	0.020
Maximum	0.410	0.500	0.450	0.500	0.470	0.400	0.500
Std. Dev.	0.116	0.127	0.113	0.120	0.107	0.090	0.122

Table 50. Female Sample IRT Summary Statistics for Word Knowledge

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.478	1.504	1.512	1.466	1.555	1.517	1.311
Variance	0.215	0.260	0.253	0.214	0.193	0.275	0.390
Skew	0.336	0.375	0.651	0.368	0.013	0.298	0.782
Kurtosis	-0.485	-0.959	-0.849	0.131	-0.588	-0.630	-0.895
Minimum	0.660	0.673	0.831	0.439	0.651	0.500	0.555
Maximum	2.434	2.500	2.500	2.423	2.462	2.500	2.500
Std. Dev.	0.464	0.510	0.503	0.463	0.440	0.525	0.624
b							
Mean	-0.632	-0.618	-0.675	-0.675	-0.479	-0.686	-0.883
Variance	0.843	1.145	1.073	1.044	1.166	1.115	1.351
Skew	0.021	-0.503	-0.182	-0.261	-0.533	-0.383	-0.282
Kurtosis	-0.883	-0.803	-0.766	-0.581	-0.786	-0.840	-0.798
Minimum	-2.278	-3.000	-2.721	-3.000	-2.990	-3.000	-3.000
Maximum	1.027	1.225	1.176	1.092	1.197	1.063	1.076
Std. Dev.	0.918	1.070	1.036	1.022	1.080	1.056	1.162
c							
Mean	0.248	0.257	0.233	0.258	0.275	0.261	0.251
Variance	0.007	0.008	0.008	0.008	0.010	0.006	0.011
Skew	0.314	0.320	0.554	0.308	0.258	0.554	0.030
Kurtosis	-0.731	-0.394	-0.345	-0.667	-0.363	-0.108	-0.927
Minimum	0.090	0.090	0.080	0.090	0.070	0.120	0.060
Maximum	0.410	0.460	0.420	0.470	0.500	0.460	0.440
Std. Dev.	0.086	0.087	0.090	0.092	0.100	0.079	0.104

Table 51. Total Sample IRT Summary Statistics for Paragraph Comprehension

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.258	1.302	1.444	1.378	1.480	1.459	1.474
Variance	0.622	0.540	0.589	0.496	0.621	0.439	0.627
Skew	0.773	0.873	0.535	0.514	0.371	0.755	0.336
Kurtosis	-1.134	-1.016	-1.480	-1.166	-1.694	-1.129	-1.623
Minimum	0.467	0.552	0.573	0.409	0.581	0.785	0.400
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.789	0.735	0.767	0.704	0.788	0.663	0.792
b							
Mean	-1.149	-0.816	-0.637	-1.046	-0.924	-0.663	-0.539
Variance	1.154	0.776	1.009	0.810	0.945	0.952	0.814
Skew	-0.126	-0.061	0.283	0.526	0.548	-0.262	0.280
Kurtosis	-0.959	-1.006	-1.375	-0.984	-1.149	-1.126	-0.527
Minimum	-3.000	-2.408	-1.982	-2.220	-2.188	-2.329	-2.104
Maximum	0.527	0.629	0.971	0.644	0.695	0.828	1.402
Std. Dev.	1.074	0.881	1.005	0.900	0.972	0.975	0.902
c							
Mean	0.133	0.190	0.189	0.205	0.159	0.205	0.316
Variance	0.013	0.023	0.029	0.018	0.030	0.021	0.020
Skew	0.350	0.243	0.350	0.503	0.938	0.209	-0.442
Kurtosis	-1.250	-1.495	-1.343	-1.112	-0.777	-0.877	-0.565
Minimum	0.000	0.000	0.000	0.050	0.000	0.000	0.000
Maximum	0.340	0.440	0.500	0.460	0.500	0.500	0.500
Std. Dev.	0.112	0.150	0.170	0.133	0.173	0.146	0.141

Table 52. Male Sample IRT Summary Statistics for Paragraph Comprehension

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.285	1.307	1.461	1.315	1.503	1.481	1.460
Variance	0.623	0.546	0.584	0.430	0.619	0.427	0.522
Skew	0.690	0.899	0.485	0.851	0.331	0.733	0.357
Kurtosis	-1.242	-1.015	-1.508	-0.507	-1.730	-1.172	-1.312
Minimum	0.460	0.595	0.574	0.462	0.588	0.848	0.400
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.789	0.739	0.764	0.656	0.787	0.653	0.722
b							
Mean	-1.104	-0.770	-0.616	-1.030	-0.888	-0.637	-0.475
Variance	1.114	0.748	0.983	0.727	0.914	0.919	1.523
Skew	-0.226	-0.096	0.320	0.463	0.528	-0.203	1.232
Kurtosis	-0.918	-0.931	-1.326	-0.926	1.130	-1.103	1.627
Minimum	-3.000	-2.349	-1.924	-2.176	-2.127	-2.266	-2.111
Maximum	0.507	0.676	1.032	0.628	0.711	0.888	3.000
Std. Dev.	1.055	0.865	0.991	0.853	0.956	0.959	1.234
c							
Mean	0.131	0.189	0.185	0.206	0.162	0.207	0.279
Variance	0.013	0.021	0.028	0.015	0.027	0.022	0.022
Skew	0.546	0.102	0.429	0.428	0.919	0.199	-0.005
Kurtosis	-0.735	-1.687	-1.251	-1.134	-0.696	-0.932	-0.826
Minimum	0.000	0.000	0.000	0.050	0.000	0.010	0.000
Maximum	0.370	0.380	0.500	0.420	0.500	0.500	0.500
Std. Dev.	0.112	0.145	0.168	0.124	0.163	0.147	0.148

Table 53. Female Sample IRT Summary Statistics for Paragraph Comprehension

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.144	1.381	1.354	1.363	1.308	1.390	1.322
Variance	0.508	0.640	0.568	0.231	0.571	0.435	0.551
Skew	1.191	0.546	0.591	0.956	0.785	0.706	0.605
Kurtosis	-0.234	-1.522	-1.218	-0.098	-1.143	-1.103	-1.214
Minimum	0.572	0.561	0.476	0.844	0.537	0.593	0.400
Maximum	2.500	2.500	2.500	2.500	2.500	2.474	2.500
Std. Dev.	0.713	0.800	0.753	0.481	0.756	0.659	0.742
b							
Mean	-1.301	-0.961	-0.775	-0.625	-1.021	-0.750	-0.848
Variance	1.157	0.940	0.908	1.828	0.803	0.970	1.000
Skew	0.240	0.368	0.360	1.044	0.431	-0.318	0.494
Kurtosis	-0.831	-1.088	-1.007	0.963	-0.925	-1.150	-0.621
Minimum	-3.000	-2.428	-2.059	-2.305	-2.485	-2.422	-2.115
Maximum	0.638	0.646	1.108	3.000	0.614	0.670	1.386
Std. Dev.	1.075	0.970	0.953	1.352	0.896	0.985	1.000
c							
Mean	0.186	0.249	0.252	0.373	0.237	0.247	0.285
Variance	0.010	0.018	0.012	0.005	0.019	0.012	0.017
Skew	1.667	0.583	0.375	0.539	0.754	0.765	0.209
Kurtosis	2.624	-0.636	-1.319	-0.954	-0.589	-0.394	-0.933
Minimum	0.070	0.040	0.100	0.280	0.050	0.090	0.080
Maximum	0.490	0.500	0.430	0.500	0.500	0.460	0.500
Std. Dev.	0.102	0.135	0.108	0.072	0.138	0.109	0.129

Table 54. Total Sample IRT Summary Statistics for Auto and Shop Information

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.153	1.105	1.273	1.335	1.187	1.196	1.109
Variance	0.309	0.311	0.449	0.505	0.436	0.431	0.440
Skew	1.124	1.393	0.706	0.622	0.990	0.968	1.020
Kurtosis	0.494	1.113	-0.881	-1.204	-0.407	-0.492	-0.206
Minimum	0.400	0.400	0.463	0.459	0.474	0.529	0.400
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.555	0.557	0.670	0.711	0.660	0.657	0.663
b							
Mean	-0.241	-0.241	-0.166	-0.141	-0.239	-0.220	-0.199
Variance	0.468	0.443	0.604	0.604	0.463	0.475	0.651
Skew	-0.089	-0.072	0.780	0.591	0.237	0.120	-0.324
Kurtosis	-1.089	-0.851	0.750	0.296	-1.159	-1.139	-0.040
Minimum	-1.326	-1.524	-1.243	-1.310	-1.340	-1.296	-2.090
Maximum	0.949	0.981	2.114	2.021	0.984	0.946	1.370
Std. Dev.	0.684	0.666	0.777	0.777	0.680	0.690	0.807
c							
Mean	0.159	0.152	0.128	0.151	0.173	0.175	0.167
Variance	0.017	0.014	0.013	0.016	0.023	0.024	0.017
Skew	0.389	0.360	0.469	0.348	0.553	0.587	0.569
Kurtosis	-1.013	1.100	-1.079	-1.038	-0.992	-0.892	-0.222
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.430	0.360	0.330	0.400	0.500	0.500	0.500
Std. Dev.	0.129	0.119	0.113	0.127	0.150	0.154	0.130

Table 55. Male Sample IRT Summary Statistics for Auto and Shop Information

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.166	1.090	1.271	1.317	1.152	1.150	1.116
Variance	0.354	0.307	0.493	0.519	0.375	0.379	0.465
Skew	1.107	1.436	0.716	0.696	0.985	1.031	0.981
Kurtosis	0.216	1.330	-1.013	-1.089	-0.308	-0.230	-0.405
Minimum	0.401	0.400	0.457	0.442	0.441	0.490	0.400
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.595	0.554	0.702	0.720	0.613	0.616	0.682
b							
Mean	-0.366	-0.373	-0.313	-0.288	-0.380	-0.370	-0.381
Variance	0.514	0.488	0.696	0.693	0.491	0.513	0.810
Skew	-0.133	-0.188	0.627	0.463	0.199	0.035	-0.580
Kurtosis	-1.082	-0.675	0.409	0.180	-1.069	-1.103	0.732
Minimum	-1.690	-1.792	-1.597	-1.657	-1.600	-1.558	-2.847
Maximum	0.837	0.864	2.042	1.968	0.846	0.815	1.290
Std. Dev.	0.717	0.698	0.835	0.833	0.701	0.716	0.900
c							
Mean	0.188	0.177	0.149	0.174	0.198	0.197	0.178
Variance	0.017	0.015	0.014	0.019	0.027	0.025	0.014
Skew	0.305	0.264	0.516	0.306	0.441	0.291	0.474
Kurtosis	-1.000	-1.133	-0.797	-1.083	-1.219	-1.215	-0.235
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.440	0.390	0.380	0.420	0.500	0.500	0.490
Std. Dev.	0.131	0.122	0.120	0.136	0.164	0.160	0.120

Table 56. Female Sample IRT Summary Statistics for Auto and Shop Information

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	0.859	0.914	0.945	0.979	0.907	0.947	0.746
Variance	0.218	0.218	0.214	0.290	0.254	0.293	0.177
Skew	1.738	1.613	1.343	1.289	1.017	0.872	2.211
Kurtosis	2.636	2.997	1.220	0.854	-0.040	-0.440	4.766
Minimum	0.400	0.400	0.419	0.400	0.400	0.400	0.400
Maximum	2.386	2.500	2.307	2.500	2.130	2.187	2.280
Std. Dev.	0.467	0.466	0.462	0.539	0.504	0.541	0.421
b							
Mean	0.901	0.933	1.096	1.081	1.317	1.185	0.757
Variance	1.189	1.151	1.061	1.022	1.128	1.419	1.212
Skew	0.250	0.292	0.222	0.113	-0 305	-0.242	-0.050
Kurtosis	-1.224	-0.953	-1.112	-1.214	-0.842	-0.978	-0.733
Minimum	-0.703	-0.825	-0.486	-0.427	-0.705	-1.094	-1.243
Maximum	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Std. Dev.	1.090	1.073	1.030	1.011	1.062	1.191	1.101
c							
Mean	0.134	0.138	0.138	0.148	0.206	0.196	0.147
Variance	0.009	0.009	0.011	0.012	0.018	0.014	0.007
Skew	0.580	0.505	0.229	0.332	0.306	-0.214	0.178
Kurtosis	-0.435	-0.668	-1.040	-0.928	-0.926	-1.223	-0.639
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.010
Maximum	0.340	0.330	0.330	0.370	0.490	0.370	0.320
Std. Dev.	0.092	0.095	0.102	0.108	0.135	0.117	0.081

Table 57. Total Sample IRT Summary Statistics for Mathematics Knowledge

Statistic	Form number						
	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.434	1.307	1.451	1.428	1.308	1.290	1.339
Variance	0.371	0.327	0.218	0.202	0.400	0.403	0.374
Skew	0.557	0.812	0.542	0.670	0.818	0.877	0.633
Kurtosis	-0.996	-0.374	-0.230	-0.254	-0.598	-0.605	-0.708
Minimum	0.644	0.611	0.792	0.780	0.413	0.527	0.422
Maximum	2.500	2.500	2.495	2.500	2.500	2.500	2.500
Std. Dev.	0.609	0.572	0.467	0.449	0.633	0.635	0.612
b							
Mean	0.303	0.168	0.275	0.275	0.168	0.159	0.214
Variance	0.918	0.598	0.552	0.534	0.704	0.706	1.142
Skew	0.526	-0.064	-0.163	-0.197	-0.695	-0.643	0.120
Kurtosis	0.634	-0.537	-1.099	-1.008	-0.392	-0.466	0.569
Minimum	-1.490	-1.508	-0.945	-0.960	-1.819	-1.809	-1.976
Maximum	3.000	1.643	1.564	1.540	1.493	1.448	3.000
Std. Dev.	0.958	0.773	0.743	0.731	0.839	0.840	1.069
c							
Mean	0.146	0.113	0.135	0.134	0.123	0.117	0.150
Variance	0.015	0.011	0.016	0.016	0.014	0.011	0.011
Skew	0.086	0.409	1.006	0.987	0.896	0.696	0.066
Kurtosis	-1.377	-0.998	0.714	0.640	-0.054	-0.636	-1.138
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.340	0.340	0.500	0.490	0.420	0.330	0.350
Std. Dev.	0.122	0.105	0.127	0.125	0.118	0.105	0.104

Table 58. Male Sample IRT Summary Statistics for Mathematics Knowledge

Statistic	Form number						
	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.492	1.352	1.477	1.443	1.326	1.304	1.399
Variance	0.398	0.345	0.230	0.204	0.406	0.385	0.386
Skew	0.462	0.699	0.383	0.470	0.775	0.824	0.479
Kurtosis	-1.147	-0.732	-0.540	-0.591	-0.716	-0.662	-0.943
Minimum	0.650	0.652	0.787	0.789	0.444	0.580	0.423
Maximum	2.500	2.500	2.478	2.449	2.500	2.500	2.500
Std. Dev.	0.631	0.587	0.480	0.452	0.637	0.621	0.621
b							
Mean	0.294	0.165	0.262	0.248	0.147	0.133	0.233
Variance	0.901	0.594	0.528	0.521	0.677	0.687	1.108
Skew	0.571	-0.091	-0.164	-0.178	-0.596	-0.580	0.049
Kurtosis	0.659	-0.713	-1.092	-1.074	-0.525	-0.509	0.769
Minimum	-1.349	-1.447	-0.981	-0.925	-1.737	-1.795	-2.056
Maximum	3.000	1.594	1.519	1.491	1.474	1.461	3.000
Std. Dev.	0.949	0.771	0.727	0.722	0.823	0.829	1.053
c							
Mean	0.152	0.115	0.135	0.130	0.121	0.115	0.158
Variance	0.015	0.012	0.017	0.017	0.012	0.010	0.011
Skew	0.031	0.379	0.906	0.959	0.807	0.560	-0.071
Kurtosis	-1.392	-1.187	0.349	0.360	-0.123	-0.832	-1.158
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.340	0.340	0.500	0.490	0.390	0.320	0.340
Std. Dev.	0.122	0.109	0.132	0.130	0.111	0.099	0.103

Table 59. Female Sample IRT Summary Statistics for Mathematics Knowledge

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.143	1.186	1.329	1.327	1.233	1.345	1.103
Variance	0.146	0.199	0.134	0.153	0.319	0.369	0.168
Skew	0.445	0.518	0.722	1.004	0.792	0.819	0.302
Kurtosis	-0.205	-0.488	-0.135	0.539	-0.358	-0.481	-0.855
Minimum	0.548	0.500	0.780	0.743	0.400	0.491	0.453
Maximum	2.031	2.201	2.244	2.397	2.486	2.500	1.872
Std. Dev.	0.383	0.446	0.366	0.392	0.564	0.607	0.410
b							
Mean	0.322	0.273	0.379	0.402	0.320	0.473	0.187
Variance	0.713	0.700	0.695	0.721	0.846	1.023	0.885
Skew	-0.017	-0.074	0.047	-0.064	-0.942	0.004	0.123
Kurtosis	-0.385	-0.282	-1.020	-0.974	0.142	0.418	-0.691
Minimum	-1.584	-1.663	-0.973	-1.107	-2.145	-1.760	-1.475
Maximum	2.088	1.894	1.973	1.971	1.534	3.000	2.200
Std. Dev.	0.845	0.836	0.834	0.849	0.920	1.011	0.941
c							
Mean	0.132	0.138	0.143	0.133	0.160	0.183	0.153
Variance	0.011	0.011	0.012	0.011	0.011	0.012	0.010
Skew	0.551	0.303	0.760	0.829	0.496	-0.064	0.338
Kurtosis	-0.441	-0.642	0.221	0.720	-0.346	-0.727	-0.698
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.380	0.360	0.450	0.440	0.400	0.420	0.380
Std. Dev.	0.105	0.103	0.111	0.105	0.106	0.111	0.098

Table 60. Total Sample IRT Summary Statistics for Mechanical Comprehension

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.013	1.012	0.939	0.955	0.990	1.002	0.985
Variance	0.357	0.360	0.167	0.223	0.233	0.197	0.181
Skew	1.695	1.668	0.968	1.368	2.285	1.741	1.745
Kurtosis	1.749	1.673	0.576	2.020	4.803	3.306	4.078
Minimum	0.491	0.478	0.425	0.417	0.428	0.428	0.452
Maximum	2.500	2.500	2.111	2.478	2.500	2.500	2.500
Std. Dev.	0.597	0.600	0.408	0.472	0.483	0.444	0.425
b							
Mean	-0.182	-0.196	-0.261	-0.288	-0.217	-0.173	-0.147
Variance	0.958	0.955	0.958	0.912	0.922	0.904	0.783
Skew	0.032	-0.075	-0.265	-0.196	0.183	0.113	-0.436
Kurtosis	-0.252	-0.301	-0.879	-0.581	-1.392	-1.409	-0.243
Minimum	-2.349	-2.430	-1.945	-2.022	-1.812	-1.670	-2.291
Maximum	1.872	1.731	1.575	1.703	1.314	1.296	1.449
Std. Dev.	0.979	0.977	0.979	0.955	0.960	0.951	0.885
c							
Mean	0.146	0.146	0.135	0.133	0.144	0.148	0.162
Variance	0.010	0.012	0.009	0.008	0.011	0.012	0.020
Skew	-0.281	-0.032	0.106	0.069	0.094	0.257	0.700
Kurtosis	-1.383	-1.160	-1.000	-1.248	-1.297	-1.204	-0.409
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.300	0.360	0.340	0.290	0.340	0.350	0.500
Std. Dev.	0.102	0.110	0.094	0.088	0.107	0.111	0.142

Table 61. Male Sample IRT Summary Statistics for Mechanical Comprehension

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	0.995	0.991	0.939	0.957	0.986	1.027	0.972
Variance	0.358	0.366	0.214	0.246	0.238	0.285	0.177
Skew	1.758	1.698	1.507	1.405	2.234	1.733	1.804
Kurtosis	1.907	1.768	2.780	1.876	4.552	2.176	4.501
Minimum	0.476	0.414	0.400	0.400	0.440	0.415	0.435
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.599	0.605	0.462	0.496	0.488	0.534	0.421
b							
Mean	-0.313	-0.316	-0.386	-0.399	-0.321	-0.285	-0.280
Variance	1.024	0.999	0.967	0.920	0.927	0.923	0.808
Skew	-0.057	-0.120	0.219	-0.201	0.196	0.164	-0.392
Kurtosis	-0.087	-0.160	-0.817	-0.618	-1.439	-1.436	-0.084
Minimum	-2.696	-2.704	-2.056	-2.099	-1.819	-1.679	-2.533
Maximum	1.757	1.601	1.567	1.618	1.214	1.196	1.342
Std. Dev.	1.012	1.000	0.984	0.959	0.963	0.961	0.899
c							
Mean	0.146	0.148	0.135	0.140	0.151	0.151	0.168
Variance	0.009	0.010	0.007	0.007	0.011	0.011	0.019
Skew	-0.260	-0.253	0.377	-0.014	0.064	0.264	0.666
Kurtosis	-1.265	-1.256	-0.265	-1.119	-1.246	-0.920	-0.219
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.290	0.300	0.340	0.290	0.340	0.360	0.500
Std. Dev.	0.097	0.099	0.083	0.086	0.104	0.105	0.136

Table 62. Female Sample IRT Summary Statistics for Mechanical Comprehension

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.040	1.047	0.979	0.913	1.011	0.923	0.771
Variance	0.326	0.248	0.302	0.263	0.329	0.104	0.082
Skew	1.199	1.082	1.644	1.739	1.506	0.981	1.015
Kurtosis	0.460	0.545	2.088	2.319	1.206	0.931	0.274
Minimum	0.400	0.404	0.401	0.416	0.425	0.404	0.400
Maximum	2.500	2.407	2.500	2.500	2.500	1.809	1.524
Std. Dev.	0.571	0.498	0.549	0.513	0.573	0.322	0.287
b							
Mean	0.653	0.567	0.576	0.556	0.645	0.691	0.671
Variance	1.115	1.129	1.335	1.296	1.647	1.427	1.273
Skew	0.394	0.112	0.028	0.115	0.271	0.087	-0.914
Kurtosis	-0.143	-0.344	-0.562	-0.198	-1.123	-1.216	0.860
Minimum	-1.111	-1.341	-1.370	-1.535	-1.505	-1.346	-2.619
Maximum	3.000	3.000	3.000	3.000	3.000	2.720	2.517
Std. Dev.	1.056	1.062	1.156	1.139	1.283	1.194	1.128
c							
Mean	0.194	0.188	0.184	0.174	0.181	0.194	0.166
Variance	0.014	0.014	0.007	0.005	0.009	0.012	0.017
Skew	-0.058	0.003	-0.266	-0.469	0.045	0.602	0.907
Kurtosis	-1.092	-0.956	-0.244	-0.471	-1.137	-0.560	0.091
Minimum	0.000	0.000	0.000	0.020	0.030	0.040	0.000
Maximum	0.380	0.400	0.370	0.290	0.350	0.450	0.490
Std. Dev.	0.117	0.119	0.086	0.069	0.097	0.111	0.131

Table 63. Total Sample IRT Summary Statistics for Electronics Information

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.216	1.199	1.039	1.048	1.268	1.256	1.168
Variance	0.409	0.371	0.211	0.278	0.447	0.333	0.356
Skew	1.001	1.135	1.019	1.787	1.023	0.977	1.219
Kurtosis	-0.347	0.051	-0.144	2.362	-0.468	-0.260	0.316
Minimum	0.469	0.507	0.542	0.567	0.559	0.642	0.517
Maximum	2.500	2.500	2.141	2.500	2.500	2.500	2.500
Std. Dev.	0.640	0.609	0.459	0.527	0.669	0.577	0.597
b							
Mean	-0.036	-0.063	-0.194	-0.188	-0.062	-0.034	-0.011
Variance	1.126	1.055	0.701	0.615	0.948	0.866	1.024
Skew	0.226	0.390	-0.174	-0.141	0.279	0.332	0.171
Kurtosis	-0.794	-0.681	-1.243	-1.072	-0.567	-0.521	-1.000
Minimum	-1.934	-1.787	-1.583	-1.578	-1.858	-1.692	-1.776
Maximum	2.001	1.976	0.998	1.093	1.777	1.735	2.085
Std. Dev.	1.061	1.027	0.837	0.784	0.974	0.930	1.012
c							
Mean	0.145	0.157	0.163	0.183	0.169	0.167	0.177
Variance	0.018	0.018	0.022	0.020	0.022	0.019	0.015
Skew	0.625	0.685	0.656	0.368	0.250	0.169	-0.276
Kurtosis	-0.415	-0.208	-0.741	-0.813	-1.493	-1.497	-1.292
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.470	0.450	0.500	0.500	0.440	0.400	0.360
Std. Dev.	0.133	0.133	0.150	0.142	0.148	0.136	0.122

Table 64. Male Sample IRT Summary Statistics for Electronics Information

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	1.220	1.178	1.091	1.020	1.292	1.321	1.156
Variance	0.428	0.392	0.330	0.297	0.528	0.493	0.377
Skew	0.972	1.226	1.267	1.864	0.896	0.955	1.131
Kurtosis	-0.435	0.226	0.340	2.551	-0.886	-0.820	0.048
Minimum	0.463	0.497	0.544	0.559	0.590	0.635	0.485
Maximum	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Std. Dev.	0.654	0.626	0.574	0.545	0.727	0.702	0.614
b							
Mean	-0.158	-0.207	-0.301	-0.345	-0.178	-0.051	-0.139
Variance	1.181	1.116	0.745	0.621	0.969	1.242	1.039
Skew	0.299	0.453	-0.182	-0.087	0.454	0.874	0.282
Kurtosis	-0.686	-0.571	-1.278	-0.953	-0.359	0.844	-0.751
Minimum	-1.973	-1.876	-1.728	-1.679	-1.941	-1.871	-1.825
Maximum	1.985	1.910	0.864	1.018	1.773	3.000	2.142
Std. Dev.	1.087	1.056	0.863	0.788	0.984	1.114	1.019
c							
Mean	0.146	0.150	0.176	0.181	0.170	0.182	0.182
Variance	0.017	0.015	0.022	0.016	0.018	0.019	0.015
Skew	0.624	0.661	0.615	0.274	0.206	0.072	-0.142
Kurtosis	-0.472	-0.592	-0.684	-0.958	-1.246	-1.418	-1.156
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.450	0.420	0.500	0.430	0.440	0.410	0.390
Std. Dev.	0.129	0.124	0.147	0.125	0.133	0.137	0.121

Table 65. Female Sample IRT Summary Statistics for Electronics Information

	Form number						
Statistic	11a	11b	12a	12b	13a	13b	13c(8a)
a							
Mean	0.933	0.823	0.787	0.834	0.955	0.943	0.939
Variance	0.359	0.039	0.175	0.269	0.201	0.170	0.367
Skew	1.392	-0.056	1.681	1.800	1.968	0.932	1.660
Kurtosis	0.772	-0.945	2.471	2.967	3.468	-0.059	1.308
Minimum	0.400	0.408	0.400	0.400	0.503	0.438	0.453
Maximum	2.500	1.133	2.090	2.500	2.417	1.877	2.500
Std. Dev.	0.599	0.199	0.419	0.519	0.449	0.412	0.606
b							
Mean	1.055	1.025	0.700	0.639	0.669	0.673	0.909
Variance	1.768	1.774	0.916	0.942	1.280	1.144	1.512
Skew	-0.145	-0.059	0.015	-0.191	0.209	0.356	-0.020
Kurtosis	-1.605	-1.475	-1.285	-1.048	-0.737	-0.723	-1.427
Minimum	-1.187	-1.005	-0.960	-1.077	-1.408	-1.122	-1.173
Maximum	2.785	2.910	2.134	2.099	3.000	2.743	3.000
Std. Dev.	1.330	1.332	0.957	0.971	1.131	1.070	1.230
c							
Mean	0.195	0.200	0.176	0.182	0.168	0.160	0.190
Variance	0.016	0.017	0.015	0.014	0.015	0.009	0.014
Skew	0.147	0.139	0.667	0.278	0.571	-0.194	0.006
Kurtosis	-0.938	-1.071	0.365	-0.479	-0.990	-0.750	-1.160
Minimum	0.000	0.010	0.000	0.000	0.010	0.000	0.000
Maximum	0.430	0.430	0.500	0.460	0.400	0.330	0.380
Std. Dev.	0.127	0.130	0.122	0.120	0.124	0.095	0.118

Summary and Conclusions for Item Analyses

Both classical and latent trait item analyses were performed for each of the subtests within each form. These results were compared across forms in the total, male, and female samples to identify systematic form differences in each of the samples, and between the male and female samples. Individual items were labeled aberrant within a sample if the biserial correlations were not as expected.

The results of the classical item analysis indicated that, in general, there was consistency across forms in the estimates of mean proportions correct and mean biserial correlations. There was evidence of a tendency for the mean difficulties on Form 12a to be lower. There was no evidence of a systematic sex-by-form effect.

The results of the IRT analyses showed somewhat less consistency across the forms. Estimating parameters in the PC subtest was deemed inappropriate. The ranges in the mean estimates of b were as high as 0.21 in the total sample, 0.42 in the male sample, and 0.42 in the female sample. The ranges for the mean a parameters across the new forms were 0.23 for the total sample, 0.30 for the male sample, and 0.20 for the female sample. There did not appear to be any consistent form bias in the mean parameter estimates.

VI. COMPOSITE SUMMARY STATISTICS

Twenty-one standard-score composites and their service equivalents are listed in Table 66. Following the recommendations of Kee, et al. (1985), raw scores on Forms 11a, 11b, 12b, 13a, and

13b were transformed to standard subtest scores using the five-form average linear equating table. These scores were then summed to form the 21 composites. Raw scores on Form 12a were transformed to standard scores using the 12a linear equating table, and these values were summed to form the composites for that form. Composites for individuals taking Form 13c were created by applying the standardizing transformations listed in Table 67 and then summing to form the composites. Descriptive statistics were calculated for each composite within each form to evaluate the distributional differences between forms in the total, male, and female samples and to evaluate differences between sexes within forms.

Table 66. Standard Score Composites and Service Equivalent

Composite		Service code	Composite		Service code
C1:	VE+AR[a]	Army GT	C10:	VE+MK+MC+GS	Army ST
		Air Force G	C11:	AR+EI+MC+AS	Marine Corps MM
		Navy GT	C12:	VE+MK+CS	Marine Corps CL
C2:	MK+EIU+AS+GS	Army GM	C13:	VE+AR+MC	Marine Corps GT
C3:	AR+MK+EI+GS	Army EL			Navy ST
		Air Force E	C14:	MC+GS+2AS	Air Force M
		Marine Corps EL	C15:	NO+CS+VE	Air Force A
		Navy EL			Navy CL
C4:	AR+MK+VE	Army CL	C16:	AR+GS+2MK	Navy E
C5:	NO+AS+MC+EI	Army MM	C17:	VE+MC+AS	Navy ME
C6:	AR+AS+MC+VE	Army SC	C18:	MK+AS	Navy EG
C7:	CS+AR+MC+AS	Army CO	C19:	VE+AR+NO+CS	Navy CT
C8:	AR+CS+MC+MK	Army FA	C20:	VE+MK+GS	Navy HM
C9:	NO+AS+MC+VE	Army OF	C21:	AR+MC+AS	Navy MR

[a]VE is formed by summing the raw score WK and raw score PC.

Table 67. Standardizing Transformations for Youth Cohort Sample[a]

General Science (GS)	SS = [(10.0/5.010)(GS raw score - 15.950)] + 50
Arithmetic Reasoning (AR)	SS = [(10.0/7.373)(AR raw score - 18.009)] + 50
Word Knowledge (WK)	SS = [(10.0/7.710)(WK raw score - 26.270)] + 50
Paragraph Comprehension (PC)	SS = [(10.0/3.355)(PC raw score - 11.011)] + 50
Numerical Operations (NO)	SS = [(10.0/10.800)(NO raw score - 37.236)] + 50
Coding Speed (CS)	SS = [(10.0/16.763)(CS raw score - 47.606)] + 50
Auto & Shop Information (AS)	SS = [(10.0/5.550)(AS raw score - 14.317)] + 50
Mathematics Knowledge (MK)	SS = [(10.0/6.393)(MK raw score - 13.578)] + 50
Mechanical Comprehension (MC)	SS = [(10.0/5.349)(MC raw score - 14.165)] + 50
Electronics Information (EI)	SS = [(10.0/4.236)(EI raw score - 11.569)] + 50
Verbal (VE)	SS = [(10.0/10.595)(VE raw score - 37.281)] + 50

[a]The standard scores are rounded to the nearest integer. Standard scores less than or equal to 20 are set equal to 20. Standard scores greater than or equal to 80 are set equal to 80.

Procedure

The mean, variance, standard deviation, skew, kurtosis, range, minimum, maximum, median, and mode were determined for each composite in the total, male, and female samples. The means and variances are summarized in Tables 68 through 70. These statistics were compared across forms in each of the samples. More complete summaries of these results are shown in Appendices C and D in Volume II.

Results

Total Sample. The descriptive statistics for the 21 composites in the total sample are summarized in Table 68. For 12 of the 21 composites, Form 13a had the highest mean value of the new forms. Form 12b had the highest mean value on five of the composites. Two-thirds (14) of the highest means occurred on either Form 13a or 13b. The lowest mean value on 13 of the 21 composites occurred on Form 11b. Seventeen of the lowest mean values occurred on either Form 11a or 11b. The range of mean values across forms was widest on composite 3 (3.048 standard score units) and smallest on composite 19 (0.859), with an average range of mean values across all composites of 1.638.

Differences between the average mean values on the new forms and the mean values on the reference form were less than 0.300 for all composites. The greatest difference (0.298) was found on composites 5 and 8. The smallest difference (0.016) was found on composite 12. The ratios of largest to smallest variances of the composites' scores across forms ranged from a high of 1.18 on composite 18 to a low of 1.03 on composite 10.

Table 68. Total Sample Summary Statistics for Standard Score Composites Formed from Five-Form Average Linear Equating Tables

	Form number						
Statistic	11a	11b	12a[a]	12b	13a	13b	13c(8a)[b]
C1: VE + AR							
Mean	100.015	99.412	100.255	100.662	100.527	100.608	100.279
Variance	243.872	228.917	221.899	231.991	217.053	221.889	221.483
C2: MK + EI + AS + GS							
Mean	201.036	201.202	202.263	203.126	203.236	202.469	201.990
Variance	867.191	867.307	879.401	871.790	846.391	880.645	872.967
C3: AR + MK + EI + GS							
Mean	198.272	198.413	199.785	201.320	200.944	200.062	199.685
Variance	922.443	912.384	894.149	906.832	881.448	912.699	891.174
C4: AR + MK + VE							
Mean	194.456	148.707	149.641	149.614	150.138	150.146	149.648
Variance	515.473	494.263	494.414	529.588	469.378	475.738	485.274
C5: NO + AS + MC + EI							
Mean	204.812	206.274	205.678	205.289	206.575	205.044	205.717
Variance	766.018	752.084	770.387	787.551	733.427	750.729	761.879
C6: AR + AS + MC + VE							
Mean	203.541	202.963	204.124	203.845	204.691	204.417	204.001
Variance	917.090	895.713	868.820	907.116	824.849	843.707	861.528
C7: CS + AR + MC + AS							
Mean	203.593	203.490	204.442	203.919	204.987	204.896	204.299
Variance	752.257	742.464	719.050	754.683	676.146	697.070	721.166
C8: AR + CS + MC + MK							
Mean	200.847	200.771	201.663	201.380	202.257	202.160	201.662
Variance	786.202	773.992	775.187	829.280	726.846	744.990	741.589

Table 68 (Continued)

Statistic	Form number						
	11a	11b	12a[a]	12b	13a	13b	13c(8a)[b]
C9: NO + AS + MC + VE							
Mean	205.609	206.113	205.513	204.194	205.949	205.047	205.546
Variance	697.886	671.890	689.879	710.479	653.101	667.001	672.111
C10: VE + MK + MC + GS							
Mean	200.985	200.564	201.636	202.233	202.090	201.734	201.529
Variance	908.885	883.394	901.995	900.752	881.479	899.185	840.215
C11: AR + EI + MC + AS							
Mean	202.745	203.125	204.289	204.940	205.317	204.415	204.172
Variance	1001.371	995.571	965.671	1001.163	920.133	943.132	975.781
C12: VE + MK + CS							
Mean	150.679	150.196	150.842	150.983	150.861	151.501	150.824
Variance	374.571	358.414	368.725	385.665	360.622	367.311	365.666
C13: VE + AR + MC							
Mean	151.354	150.949	151.959	152.355	152.349	152.144	151.996
Variance	553.266	532.421	517.866	540.760	503.213	512.511	497.633
C14: MC + GS + 2AS							
Mean	205.324	205.110	206.011	205.283	206.686	206.001	205.593
Variance	1071.276	1073.614	1067.787	1054.398	1011.170	1029.578	1078.906
C15: NO + CS + VE							
Mean	152.728	153.275	152.532	152.064	152.557	152.459	152.700
Variance	350.958	334.240	342.484	355.982	347.063	354.111	348.898
C16: AR + GS + 2MK							
Mean	197.916	197.359	198.435	198.198	199.453	198.861	198.304
Variance	989.842	982.615	975.916	1026.573	922.280	943.046	952.335
C17: VE + MC + AS							
Mean	154.119	153.739	154.437	154.161	154.641	154.551	154.300
Variance	538.470	528.771	525.686	537.923	499.263	506.806	517.647
C18: MK + AS							
Mean	101.627	101.309	101.550	100.442	101.954	101.811	101.374
Variance	212.646	213.926	217.759	233.484	197.381	203.201	216.801
C19: VE + AR + NO + CS							
Mean	202.150	202.499	202.219	201.748	202.607	202.325	202.401
Variance	655.685	620.804	633.129	665.280	619.860	637.056	628.609
C20: VE + MK + GS							
Mean	149.646	149.027	149.933	150.541	150.268	150.198	149.813
Variance	508.111	488.342	496.765	490.037	495.395	504.873	474.519
C21: AR + MC + AS							
Mean	152.948	152.776	153.554	152.866	154.214	153.675	153.423
Variance	585.074	581.865	556.145	587.036	521.966	531.533	561.188

[a]Formed from corresponding individual linear equating table.

[b]Not equated.

Males. The results of the descriptive statistics in the male sample were similar to those in the total sample and are summarized in Table 69. Form 13a had the highest mean value of the new forms on 12 of the 21 composites, and 13b had the highest mean on 2. Thus, two-thirds of the highest means occurred on Form 13a or 13b. Form 11a had the lowest mean on 13 of the composites and Form 11b had the lowest on four more of the composites. As in the total sample, the range across the new forms in the male sample was widest for composite 3 (3.312) and smallest for composite 19 (0.853). The average range across the new forms for all composites was 1.716.

Differences between the average means for the new forms and the comparable mean values for the reference form were less than 0.620 for all composites. The largest difference (0.616) occurred on composite 11 and the smallest difference (0.007) occurred on composite 20. The ratios of largest to smallest variances of the scores across forms were similar to those found in the total sample and ranged from a high of 1.17 on composite 18 to a low of 1.04 on composites 2 and 10.

Table 69. Male Sample Summary Statistics for Standard-Score Composites Formed from Five-Form Average Linear Equating Tables

	Form number						
Statistic	11a	11b	12a[a]	12b	13a	13b	13c(8a)[b]
C1: VE + AR							
Mean	100.136	99.608	100.301	100.850	100.655	100.799	100.569
Variance	250.072	232.630	226.772	235.955	223.503	225.878	226.545
C2: MK + EI + AS + GS							
Mean	204.164	204.198	205.550	206.529	206.503	205.719	205.269
Variance	859.840	859.020	858.209	847.573	829.378	862.926	864.610
C3: AR + MK + EI + GS							
Mean	200.041	200.098	201.651	203.353	202.731	201.936	201.745
Variance	946.151	931.020	905.208	915.946	894.532	920.047	904.851
C4: AR + MK + VE							
Mean	149.728	148.971	149.780	149.978	150.358	150.445	149.921
Variance	530.869	506.145	507.227	541.773	483.956	486.225	498.068
C5: NO + AS + MC + EI							
Mean	208.050	209.325	209.039	208.690	209.878	208.276	209.153
Variance	753.530	740.723	747.739	766.167	717.702	734.817	750.001
C6: AR + AS + MC + VE							
Mean	206.332	205.761	206.789	206.739	207.533	207.254	207.072
Variance	910.083	880.205	864.417	894.989	827.327	841.857	857.917
C7: CS + AR + MC + AS							
Mean	205.806	205.676	206.561	206.171	207.188	207.095	206.700
Variance	753.648	738.689	723.302	752.785	687.370	706.154	730.143
C8: AR + CS + MC + MK							
Mean	201.591	201.417	202.282	202.183	202.911	202.852	202.488
Variance	808.622	790.501	799.337	850.254	752.133	767.190	765.708
C9: NO + AS + MC + VE							
Mean	207.694	208.064	207.623	206.377	208.192	207.200	207.750
Variance	706.487	677.572	695.574	716.785	663.134	674.857	684.320

Table 69 (Continued)

Statistic	Form number 11a	11b	12a[a]	12b	13a	13b	13c(8a)[b]
C10: VE + MK + MC + GS							
Mean	202.393	201.845	203.105	203.872	203.734	203.321	203.240
Variance	933.260	898.644	922.374	920.996	898.776	914.639	857.924
C11: AR + EI + MC + AS							
Mean	206.688	207.022	208.204	209.053	209.220	208.329	208.475
Variance	967.740	956.399	926.904	953.958	891.712	910.862	939.690
C12: VE + MK + CS							
Mean	149.971	149.450	150.134	150.379	150.251	150.873	150.038
Variance	383.932	364.147	376.992	394.186	369.309	372.881	371.375
C13: VE + AR + MC							
Mean	152.527	152.139	153.030	153.623	153.553	153.365	153.508
Variance	563.707	535.752	528.739	548.858	515.743	521.705	504.983
C14: MC + GS + 2AS							
Mean	209.959	209.640	210.701	210.067	211.545	210.759	210.487
Variance	1008.580	1008.801	999.082	979.963	950.239	971.112	1031.128
C15: NO + CS + VE							
Mean	151.425	151.912	151.349	150.830	151.414	151.280	151.404
Variance	352.467	332.914	343.030	356.320	349.228	351.126	349.475
C16: AR + GS + 2MK							
Mean	198.823	198.114	199.274	199.257	200.302	199.814	199.165
Variance	1016.353	1006.492	998.121	1049.010	945.393	961.497	979.380
C17: VE + MC + AS							
Mean	156.649	156.238	156.929	156.799	157.325	157.148	157.032
Variance	528.299	514.054	516.296	524.410	490.835	498.811	509.636
C18: MK + AS							
Mean	103.397	102.985	103.238	102.244	103.684	103.534	102.916
Variance	204.693	207.592	210.442	224.361	192.463	198.024	212.674
C19: VE + AR + NO + CS							
Mean	201.108	201.434	201.208	200.770	201.623	201.386	201.444
Variance	670.467	631.917	644.266	675.311	634.016	643.748	643.105
C20: VE + MK + GS							
Mean	150.002	149.314	150.375	151.099	150.836	150.755	150.302
Variance	525.720	500.812	510.339	504.407	507.446	515.115	487.396
C21: AR + MC + AS							
Mean	155.879	155.675	156.348	155.829	157.087	156.560	156.543
Variance	561.813	555.553	536.210	561.192	509.519	516.156	545.004

[a]Formed from corresponding individual linear equating table.
[b]Not equated.

Females. The results of the descriptive analyses of the composites in the female sample differed from those in both the total and male samples. In the female sample, there was less tendency for one form to dominate the high or low mean values across composites. Table 70 shows that Form 13a had the highest mean value on 9 of the 21 composites and 11b had the highest mean on 5. Form 12b had the lowest mean on 9 of the 21 composites and 11b had the lowest on 5. The widest range across new form mean values occurred on composite 9 (3.174) and smallest range occurred on composite 20 (0.568). The average range over the 21 composites was 1.711.

Differences between the average mean values on the new forms and the comparable mean values on the reference form were less consistent in the female sample than in either the male or total sample. The largest difference was 1.803 and occurred on composite 18. There were three other differences greater than 1.0: 1.285 on composite 14, 1.223 on composite 2, and 1.016 on composite 5. The smallest difference (0.016) occurred on composite 3. The ratios of largest to smallest variances of the scores across the new forms ranged from a low of 1.07 on composite 10 to a high of 1.42 on composite 21.

Table 70. Female Sample Summary Statistics for Standard-Score Composites Formed from Five-Form Average Linear Equating Tables

	Form number						
Statistic	11a	11b	12a[a]	12b	13a	13b	13c(8a)[b]
C1: VE + AR							
Mean	99.380	98.367	100.006	99.648	99.838	99.588	98.876
Variance	210.831	207.327	195.429	209.574	181.981	199.258	194.416
C2: MK + EI + AS + GS							
Mean	184.578	185.068	184.391	184.807	185.637	184.981	185.988
Variance	583.708	602.654	616.581	604.121	571.590	613.639	605.734
C3: AR + MK + EI + GS							
Mean	188.961	189.345	189.632	190.370	191.321	189.982	189.642
Variance	694.740	713.700	712.203	715.821	702.179	752.905	703.271
C4: AR + MK + VE							
Mean	148.027	147.299	148.876	147.648	148.961	148.545	148.328
Variance	432.170	427.409	424.264	459.668	389.700	416.449	420.727
C5: NO + AS + MC + EI							
Mean	187.771	189.839	187.404	186.978	188.774	187.655	188.945
Variance	486.315	492.416	498.231	505.203	443.022	477.787	481.193
C6: AR + AS + MC + VE							
Mean	188.852	187.900	189.630	188.262	189.377	189.156	189.017
Variance	697.410	709.418	644.287	684.611	534.291	577.595	608.917
C7: CS + AR + MC + AS							
Mean	191.948	191.721	192.918	191.789	193.130	193.070	192.586
Variance	583.759	597.576	538.996	590.484	449.712	482.221	512.103
C8: AR + CS + MC + MK							
Mean	196.929	197.306	198.287	197.051	198.736	198.447	197.640
Variance	650.173	669.855	630.787	694.428	576.742	609.230	604.373

Table 70 (Continued)

Statistic	Form number						
	11a	11b	12a[a]	12b	13a	13b	13c(8a)[b]
C9: NO + AS + MC + VE							
Mean	194.632	195.615	194.034	192.441	193.859	193.460	194.792
Variance	509.424	509.329	503.091	513.117	426.414	465.588	473.388
C10: VE + MK + MC + GS							
Mean	193.578	193.682	193.643	193.407	193.232	193.192	193.180
Variance	715.567	743.743	715.844	699.889	696.283	729.915	670.365
C11: AR + EI + MC + AS							
Mean	181.990	182.124	183.001	182.799	184.292	183.351	183.170
Variance	665.980	683.583	639.987	673.726	549.898	590.737	620.840
C12: VE + MK + CS							
Mean	154.404	154.240	154.686	154.221	154.153	154.884	154.670
Variance	308.904	307.374	306.494	327.560	301.367	323.975	319.922
C13: VE + AR + MC							
Mean	145.185	144.552	146.129	145.524	145.862	145.575	144.619
Variance	453.181	465.407	418.698	442.106	386.397	411.981	396.401
C14: MC + GS + 2AS							
Mean	180.934	180.702	180.511	179.536	180.499	180.390	181.700
Variance	693.466	715.800	671.514	668.779	526.984	566.816	625.058
C15: NO + CS + VE							
Mean	159.587	160.646	158.961	158.702	158.711	158.813	159.044
Variance	287.128	275.908	290.766	302.147	290.893	322.489	297.491
C16: AR + GS + 2MK							
Mean	193.139	193.310	193.868	192.485	194.891	193.738	194.117
Variance	823.454	833.676	830.810	867.498	774.040	812.994	799.525
C17: VE + MC + AS							
Mean	140.802	140.276	140.889	139.961	140.178	140.573	140.966
Variance	381.089	392.699	359.532	371.631	297.061	318.349	342.711
C18: MK + AS							
Mean	92.314	92.279	92.372	90.738	92.638	92.538	93.851
Variance	151.323	151.318	157.836	170.832	121.131	129.147	151.089
C19: VE + AR + NO + CS							
Mean	207.636	208.270	207.703	207.003	207.910	207.396	207.095
Variance	542.270	519.820	537.289	579.003	510.956	570.711	530.936
C20: VE + MK + GS							
Mean	147.773	147.496	147.520	147.531	147.207	147.205	147.437
Variance	411.413	417.507	416.253	402.263	419.953	439.418	405.175
C21: AR + MC + AS							
Mean	137.521	137.157	138.366	136.915	138.738	138.150	138.193
Variance	424.427	434.214	391.492	424.331	305.550	328.464	360.921

[a] Formed from corresponding individual linear equating table.

[b] Not equated.

Male and Female Comparisons. For 18 of the 21 composites, males, on the average, scored higher than females. The three exceptions were on composites 12, 15, and 19, the only three composites with both VE (WK and PC) and CS as part of the summed standard subtest scores. The largest difference between the average male and female mean scores was 29.810 and occurred on composite 14. The smallest difference in mean scores was 0.941 and occurred on composite 1. For 8 of the 21 composites, the form with the highest mean score was the same in the male and female samples, and for 11 of the 21 composites, the form with the lowest mean score was identical in the male and female samples.

There was less consistency in the differences between average new form means and the reference means in the female sample compared to the male sample. Whereas in the male sample, 18 of the 21 mean scores on the reference form composites were greater than the average mean value for the new forms, in the female sample only 14 of the reference form means were greater. In the male sample, all of the differences between reference and average means for the new forms were less than 0.620, and 19 of the 21 differences were less than 0.500. In the female sample, these differences were as large as 1.803, and 11 of the 21 differences were greater than 0.500.

Conclusions

There was evidence in both the total and male samples of higher mean composite scores on Form 13a and lower mean composite scores on Form 11b. The new forms' mean values in the female sample also showed a disproportionate number of high means for Form 13a, but the lowest means tended to occur on Form 12b. The average range of mean values across the composites was similar for the total, male, and female samples.

On average, males scored higher than did females on the majority of the composites. The average means for the new forms were more similar to the comparable reference means in the male sample than in the female sample.

VII. SUMMARY

Between October and November of 1984, approximately 120,000 examinees were tested on the six new forms (11a, 11b, 12a, 12b, 13a, and 13b) and a reference form (8a) of the ASVAB. These data were analyzed to assess the parallelism of the new forms in the total sample and to determine whether any sex-by-form interaction was present. The data were first edited to remove questionable test data and were then evaluated to assess the equivalence of the groups completing each form. Following these initial analyses, the parallelism of the new forms was assessed.

The results from both the data editing procedures and the evaluation of group equivalence showed some differences related to form, but these differences were minor. The only form-related pattern of examinee deletion involved few examinees (less than 0.001%) with form coding problems on Form 13c. After data editing, the data for over 99% of the examinees who completed each form of the ASVAB were retained for further analysis. Though there were differences in the numbers of individuals completing each form, there did not appear to be any difference between the forms in the distributions of sex, education level, and race. It was concluded that the groups completing each form were statistically equivalent.

In order to assess the parallelism of the new forms and to identify any sex-by-form interaction, a series of analyses were performed. The distributions of subtest scores were compared across forms in the total, male, and female samples. The structure of the interrelationships among subtest scores was evaluated between forms, and the mean item statistics for each form were compared in the three samples.

The descriptive statistics associated with the score distributions for the individual subtests showed a tendency for subtest means to be lower on Form 12a and higher on Form 13a, with no evidence of a sex-by-form interaction. The reliabilities and standard errors of measurements computed for each subtest within a form showed consistency across the new forms. The differences between the male and female reliabilities and standard errors of measurement did not appear to be related to the form being used.

The results of the classical item analyses were also supportive of the parallelism of the new forms. The ranges across the new forms of the mean proportions correct and the mean biserial correlations were consistently small. The estimates of mean proportion correct on Form 12a tended to be lower than those on the other forms. The results of the classical item analysis did not support a sex-by-form interaction. The results of the IRT analyses on the power subtest items were less consistent. Excluding the results for the PC subtest, the ranges in the mean estimates of the b parameters were as high as 0.21 in the total sample, 0.30 in the male sample, and 0.42 in the female sample; and the ranges in the mean estimates of the a parameters were as high as 0.23 in the total sample, 0.30 in the male sample, and 0.20 in the female sample. There did not appear to be any systematic form-related patterns in the means of the IRT parameters.

The structure of the forms was investigated by comparing subtest intercorrelations and by comparing the factor structures of these correlation matrices. In 98% of the total sample correlation comparisons, the differences between forms in the amount of variance explained by the relationship between two subtests was less than 10%. This close agreement between the structure of the new forms was reflected in the factor analytic results in the total, male, and female samples. The same four factors were extracted from each form, and each solution accounted for 96% of the common variance.

Though there were differences between the male and female intercorrelations and factor results, these differences appeared to be consistent across forms. The largest differences between male and female correlations occurred on the MC and EI subtests. These differences were reflected in the factor analytic results where the factor loadings on the technical information factor were lower in the female sample when compared to the male sample.

In conclusion, the investigation of the parallelism of the new forms of ASVAB evaluated the distribution of the scores, the mean item statistics, and the structure of the scores across the forms in the total, male, and female samples. There was some evidence for lower mean raw scores associated with Form 12a and higher scores associated with Form 13a, though these differences were not consistent across all subtests. Though there were differences between the male and female samples on many of the statistics, these differences did not appear to be systematically related to the form being used and, thus, were not indicative of a sex-by-form interaction.

References

Birnbaum, A. (1968). Some latent trait models and their use in inferring an examinee's ability. In F. M. Lord & M. R. Novick (Eds.), Statistical theories of mental test scores. Reading, MA: Addison-Wesley.

Jensema, C. J. (1976). A simple technique for estimating latent trait mental test parameters. Educational and Psychological Measurement, 36, 705-715.

Prestwood, J. S., Vale, C. D., Massey, R. H., & Welsh, J. R. (1985). Armed Services Vocational Aptitude Battery: Development of Forms 11, 12, and 13 (AFHRL-TR-85-16 [Volume I, AD-A160 584; Volume II, AD-A160 585]). Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

Ree, M. J., Mathews, J. J., Mullins, C. J., & Massey, R. H. (1982). Calibration of Armed Services Vocational Aptitude Battery Forms 8, 9, and 10 (AFHRL-TR-81-49, AD-A114 714). Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

Ree, M. J., Welsh, J. R., Wegner, T. G., & Earles, J. A. (1985). Armed Services Vocational Aptitude Battery: Equating and implementation of Forms 11, 12, and 13 in the 1980 youth population metric (AFHRL-TP-85-21, AD-A162 563). Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

Wood, R., Wingersky, M., & Lord, F. (1976). LOGIST: A computer program for estimating examinee ability and item characteristic curve parameters (Research Memorandum 76-6). Princeton, NJ: Educational Testing Service.

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